Stock Assessments for British Columbia Herring in 1986 and Forecasts of the Potential Catch in 1987

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by

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ABSTRACT

Haist, V., J. F. Schweigert, and D. Fournier. 1987. Stock assessments for British Columbia herring in 1986 and forecasts of the potential catch in 1987. Can. MS Rep. Fish. Aquat. Sci. 1929: 63 p.

Herring stock abundance in British Columbia waters was assessed for 1986, and forecasts were made for 1987 using two methods: (1) escapement model, and (2) age-structured model, analysis. The escapement model was modified to introduce age structure information and explicitly separate growth and recruitment. The age-structured model was modified to incorporate an availability term to estimate partial recruitments. Diving spawn survey data was incorporated into the escapement model wherever available.

Forecasts of pre-fishery biomass are obtained by weighting the estimates from the two models. The forecasts, assuming average recruitment, are for 66,810 tonnes to the northern and 101,270 tonnes to the southern stock assessment regions. These estimates represent a substantial increase over 1986 levels, reflecting average or better recruitments to all the southern areas during the last spawning run.

The recommended 1987 catch (20% of the 1987 forecast herring run for stocks above CUTOFF levels) for the entire B.C. coast is 33,470 tonnes. All areas should be available to the fishery in 1987. However, concern has been noted for the Queen Charlotte Islands stocks where spawn deposition has dropped markedly and the dominant 1977 year-class has all but disappeared from the stock.

Key words: Clupea harengus pallasi, Pacific herring, stock assessment, forecasts, age-structured analysis.

RESUME

Haist, V., J. F. Schweigert, and D. Fournier. 1987. Stock assessments for British Columbia herring in 1986 and forecasts of the potential catch in 1987. Can. MS Rep. Fish. Aquat. Sci. 1929: 63 p.

On a évalué les effectifs des stocks de hareng de la Colombie-Britannique en 1986 et on a effectué des prévisions pour 1987 à l'aide d'analyses d'un modèle de l'échappée et d'un modèle structuré selon les âges. On a modifié le premier pour y inclure des données sur la structure des âges afin de clairement séparer la croissance et le recrutement; de même, on a modifié le modèle structuré selon les âges pour y incorporer une valeur de disponibilité servant à estimer les recrutements partiels. Des données de relevés de la fraie effectués par des plongeurs en scaphandre autonome one été utilisées dans le modèle de l'échappée quand elles étaient disponibles.

Une pondération des estimations générées par les deux modèles a servi aux prévisions de la biomasse avant l'exploitation. Si l'on suppose un recrutement moyen, les prévisions s'élevent à 66 180 t dans la zone nord d'évaluation des stocks et à 101 270 dans la zone sud. Ces estimations représentent une hausse marquée par rapport aux niveaux de 1986 et traduisent des recrutements moyens ou supérieurs dans tous les secteurs sud pendant la dernière fraie.

Pour tout le littoral de la C.-B., on recommande des captures de 33 470 t en 1987 (soit 20% de la fraie prévue en 1987 chez les stocks à des niveaux supérieurs à la limite). Tous les secteurs devraient être ouverts à la pêche en 1987. Toutefois, on se soucie des stocks des Îles Reine-Charlotte où le frai a accusé une baisse marquée et la classe dominante de 1977 a quasiment disparu du stock.

Mots-clés: Clupea harengus pallasi, hareng du Pacifique, évaluation de stock, prévisions, analyse structurée selon les âges

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FOREWORD

This report was prepared by the Population Dynamics Program of the Herring Section (Biological Sciences Branch), and contains proposed catch levels for herring for the 1986/87 season. These recommended catches are based primarily on biological considerations, and may vary with those finally adopted by the Herring Stock Assessment Committee. The final fishing plans adopted by Fisheries Management will be based not only on biological considerations, but also economic and social, enforcement, and other factors.

Results contained in this report were presented to the Herring Stock Assessment Committee in September of 1986.

ACKNOWLEDGMENTS

This document not only represents the efforts of the Population Dynamics Program but numerous other members of the departmental staff play key roles in collection and processing of data. Herring ages were determined by Margaret Burke and Karen Charles of the Pacific Biological Station Ageing Unit. Lorena Rosenfeld processed the catch, sample, and spawn data and maintained the pertinent data bases. Also, Fisheries Operations personnel and contractors contribute to the sampling effort.

1. INTRODUCTION

1.1 GENERAL

Forecasting the potential catch that can be removed from herring stocks requires an assessment of the present stock status and the determination of factors which affect stock dynamics, in particular, recruitment. Traditionally, equilibrium based methods such as yield models have been favoured. They assume constancy in age structure, growth, and mortality. However, herring are strongly affected by changes in environmental conditions thus making equilibrium models unattractive. The methods we use estimate current stock conditions on the basis of which potential catches are recommended. Catch levels have been formulated to ensure conservation of the stocks.

In this report we present two methods to assess present herring stock status: 1) an escapement model (Schweigert and Stocker 1987); and 2) an age-structured model (Fournier and Archibald 1982). Both methods use a 36-year time series of catch and spawn deposition information and age structure and size at age data obtained from biological samples.

The escapement model has been modified for the current assessments to incorporate age structure information. This has the advantage of explicitly separating the growth and recruitment components of stock production. In addition, for the first time, stock biomass estimates obtained from diving spawn surveys are used wherever available. In all other areas the model continues to use data from surface surveys. The surface surveys are adjusted to "diver" observations, based on information obtained from dual surveyed spawns.

The age structured model is little changed from that used in previous years. The main exception is that the catch equations are reparamaterized to include an availability term, which accounts for partial recruitment to the spawning, and therefore fishable, stock.

1.2 DATA BASE

The primary data sources for the stock assessments are spawn survey data, commercial catch landing data, and age composition data from biological samples of commercial and pre-fishery charter and research catches. These data are available on computer files for the period 1950 to 1986. This time span includes the reduction fishery period to 1968 and the subsequent "roe" fishery period starting in the early 1970s.

Of the three data sets, the spawn data contain the largest measurement errors. We feel that the quality of spawn surveys has improved greatly over the 36-year span of these observations. This improvement is a

result of increased numbers of people and vessels being involved in spawn surveys, increased attention to data measurements, increased coverage of subtidal spawnings, and increased research on estimating egg deposition from spawn observations. The only consistent observations made during the 36 years of spawn surveys are the length, the width, and a measure of intensity of spawnings. The escapement model estimates absolute egg numbers from these observations and includes a width conversion to adjust for the inability to survey subtidal spawns adequately. The age-structured model uses a spawn index which sums lengths times standardized widths and intensities.

Catch information was obtained from landing slip data. Both models use the landing slip data summed by season (seasons run from July 1 to June 30). The 1985/86 catch figures are based on hailed estimates because sales slip data were not available for timely analysis. The sales slips record catch in tonnes. Numbers of fish in the catch were calculated using the average fish weight from catch samples for the season.

Age structure data are used in both models. The information from catch samples are used for years when there were commercial fisheries. For years with no fisheries, or when catch samples do not appear to be representative, pre-fishery and research samples are also used. Additional data in the biological sampling data base used in the age-structured model are age specific fecundities and average weights at age.

1.3 STOCK CONSIDERATIONS

The stock concept introduced for the 1985 assessment (Haist et al. 1986) is used this year for both assessment models. In the Queen Charlotte Islands the fish spawning in the Skincuttle-Selwyn area (sections 21, 24 and 25; Fig. 1.1) are treated as one stock. The stock concept for the Prince Rupert District remains unchanged encompassing fish in areas 3 to 5. The revised central coast stock concept separates the migratory stocks from the local stocks. The migratory component used in the current analysis includes sections 67, 72-76, and 85. The Strait of Georgia is separated into two stock groupings. The northern group includes section 132, all of areas 14 to 16, and 17N. The southern stock comprises areas 17S, 18 and 19. The two stock groupings used for the west coast of Vancouver Island are southern (areas 23 and 24) and northern (areas 25 to 27).

Additionally, biomass estimates from the escapement model are presented for minor and resident stocks. The level of geographic aggregation used for these estimates is the section (Fig. 1.1, 1.2; Hourston and Hamer 1979).

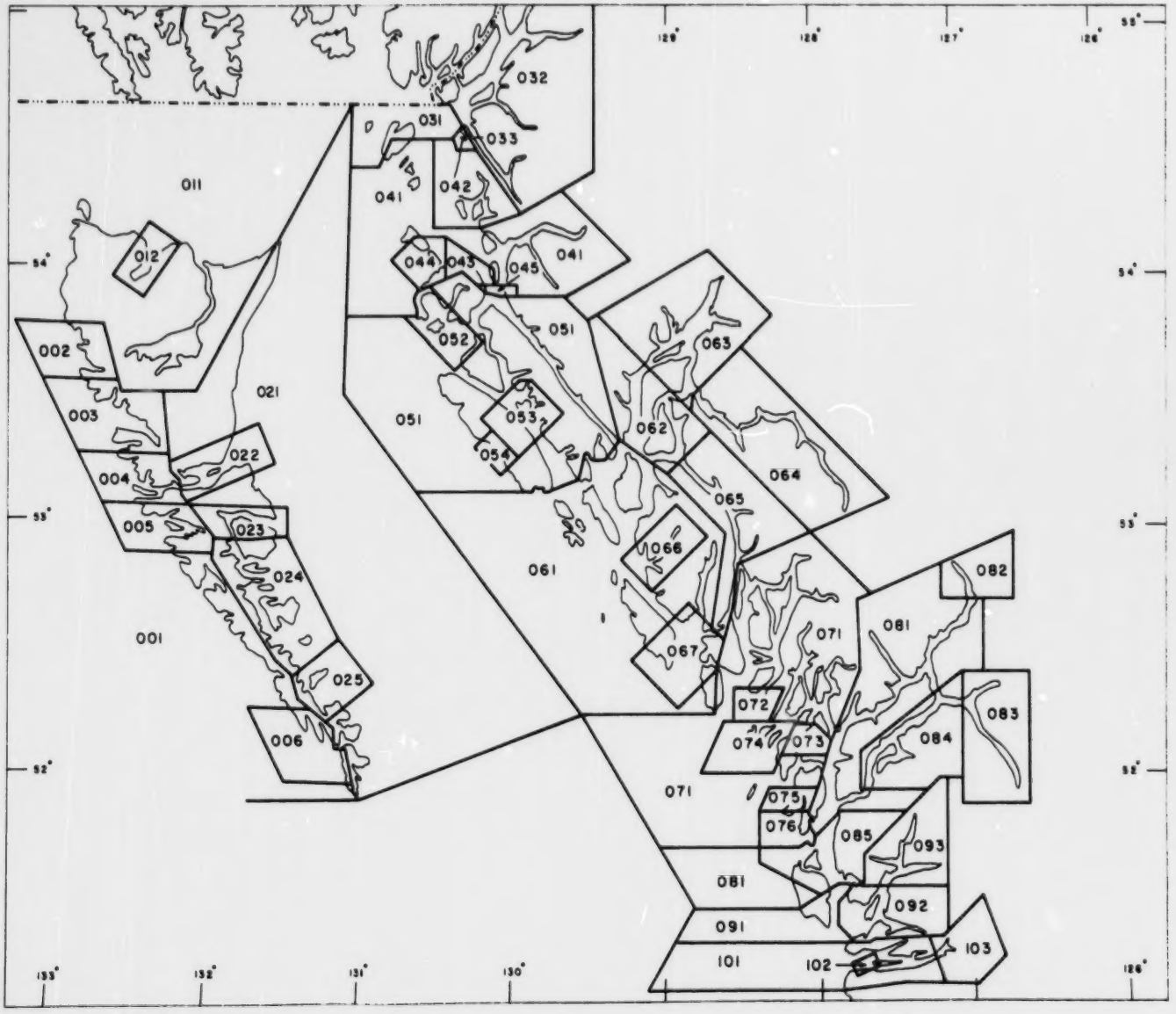

Fig. 1.1. Herring sections in northern B.C.

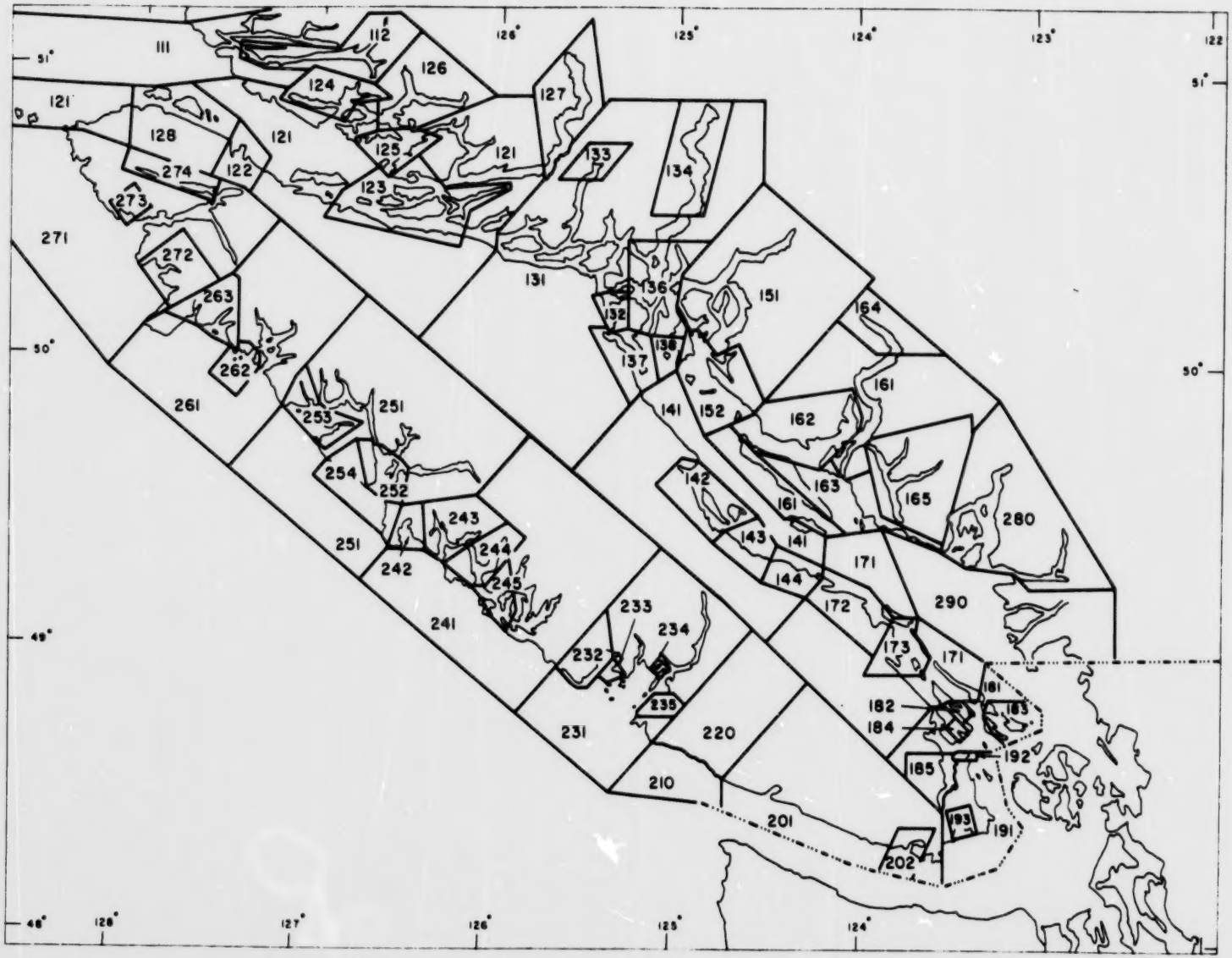

Fig. 1.2. Herring sections in southern B.C.

2. ESCAPEMENT MODEL

The escapement model was first introduced in its present form for the 1984 assessments (Haist et al. 1985). It has been modified substantially from the version used for the 1985 assessment and 1986 forecasting procedures (Haist et al. 1986). The major change has been the addition of age-structure information which permits the separation of stock production into growth and recruitment components. This permits comparisons with numbers generated by the age-structured model and also allows comparison of the results to the estimates produced by Hourston (1981) for the early years of the roe fishery. In addition, for the first time, we have used information from diving surveys as the best estimate of the escapement for those areas for which it is available. For all other areas the fishery officer surface survey data is adjusted as described below. In this year's assessment we present estimates only for the 7 stock assessment regions (Tables 2.1, 2.2) identified in last year's report (Haist et al. 1986) rather than for management units and divisions which are now not generally used in the decision process. We have also included stock estimates for all sections which contain spawn but are not included in the major stock assessment regions. These minor or resident stocks could perhaps support very small fisheries, impoundments, or spawn-on-kelp operations (Tables 2.3 to 2.5).

2.1 METHODS

For the escapement method, the average potential catch for each stock assessment region is forecast by taking the harvest rate (0.2) times the forecast run (tonnes of spawners). The forecast run (millions of fish) is the estimated escapement from last year times an average survival rate (0.64) plus an estimate of recruitment. Recruitment was estimated as poor, average, and good by calculating the means of the 25% poorest, the middle 50%, and the 25% best recruitments observed during 1951-1986. The estimates of total catch (tonnes) and spawning escapement (billions of eggs) are converted to fish at age based on the sampling data for each area. For each area the age-structure and average weight at each age are calculated from all samples for the area given a minimum of four samples per season. In the absence of four samples, the averages for the division, the alternate division, or the whole north or south are used to convert the biomass to fish. After survivals and recruitment are determined, the numbers are converted back to tonnages using the same sampling data. For the forecast year the average weights at age from the present year are used to calculate the tonnage from numbers at age. The estimates of spawning biomass in the present year and forecasts for 1987 are presented in Table 2.6 for the seven stock assessment regions.

The calibration equations used to convert surface spawn survey data to comparable diver estimates differ slightly from those used for the 1986 forecast (Haist et al. 1986). For the 1987 forecasts we have incorporated new data comparing fishery officer surface survey with diver estimates of spawn width and estimates of egg density with average egg layers (Fig. 2.1, 2.2).

This new data was collected during the 1986 diving spawn surveys which were conducted in all areas of the coast except the Queen Charlotte Islands. In particular, this was the first year comparative data was available for the central coast spawns.

Bivariate scatter plots indicate that the diver widths exceed the surface survey estimates, most markedly at the lower end of the range (Fig. 2.1). Analyses of covariance indicated that there were no significant area to area differences in the regression of diver and surface survey width ($P=0.043$) so one coastwide equation of the form :

$$\text{Diver width} = 77.87 + 0.80 \text{ surface survey width}$$

was used to adjust widths (Table 2.7). Comparison of the adjusted to observed widths also indicates a considerable scatter. It appears that the wider spawns are adjusted reasonably well but there is a large degree of variation about the smaller spawn widths with overestimation of some of the narrower spawn widths (Fig. 2.2).

The regression relationship between the eggs/m^2 and the surface survey egg layers also indicates a large scatter of points about the line (Fig. 2.3). This suggests that the surface survey estimate of mean egg layers is not a very sensitive indicator of the relative density of the spawn. With the addition of this year's data, the relationship to estimate egg density appears to be exponential rather than linear so an equation of the form:

$$\text{Eggs/m}^2 = \exp (5.23 + 0.480 \log_e \text{ average layers})$$

was used to predict egg density (Table 2.7). The relationship between the observed eggs/m^2 and the predictions from the best fit regression equation in Table 2.7 indicate slightly less scatter than for the unadjusted data but estimated densities are somewhat lower than those observed (Fig. 2.4; Table 2.8).

Both of these relationships estimate values very similar to those used in last year's assessment. Taken together, the estimates of total tonnes of spawners predicted by the application of the calibrations is virtually identical to the observed values (Fig. 2.5; Table 2.8). Apparently the opposing trends of slight overadjustment of narrow widths and underestimates of egg density compensate one another to produce quite accurate tonnage estimates.

The estimates of stock abundance using the new parameters are also very similar to those used for the 1985 assessment (Fig. 2.5; Table 2.7). Raw fishery officer lengths are still multiplied by adjusted widths to obtain area of spawn deposition. The fishery officer widths are adjusted to a 'diver width' using information from dual diver-fishery officer surveyed spawns. Spawn widths for Johnstone Strait (Statistical Areas 9-13) were not adjusted because of the narrow vegetation band observed during the diving survey in these areas during 1985 and 1986. It was felt that the surface survey would accurately estimate the spawn widths in these areas. Egg density is again estimated from a regression of egg density from diver surveyed spawns and the average fishery officer estimated layers for the same spawns. Spawn area times average egg density divided by 10^8 eggs per tonne of spawners is

used to calculate escapement from the fishery. Catch plus escapement yields the estimate of total pre-fishery stock.

2.2 RESULTS

The 1987 forecast run to the Queen Charlotte Islands assuming average recruitment is 5500 t (Table 2.6). This stock has been declining slowly since 1981 but the decline this year is apparently due to the aged state of the very strong 1977 year-class (Table 2.1; Fig. 2.6). A poor recruitment in this area would lower the forecast to a worrisome 3600 t. It should be noted that there is some uncertainty in the escapement estimates for this region due to the significant amount of spawn on the giant kelp, Macrocystis sp., which is very difficult to survey from the surface as well as with SCUBA. We suspect that the spawn deposition in the area may have been underestimated because of difficulty in assessing the deposition on kelp and hope that a more intensive diving survey can be undertaken in the area during 1987.

The forecast runs for the Prince Rupert District with average and good recruitment are 21,000 and 31,900 t, respectively (Table 2.6). This stock has been increasing steadily since the closure in 1982 (Table 2.1; Fig. 2.6). It appears to be approaching the 25-40,000 t level of the 1950s and 1960s and so appears to be in particularly good shape.

Forecasts for the central coast are 12,800 and 17,700 t with poor and average recruitment, respectively (Table 2.6). This stock appears to be below the reduction fishery levels of 40-50,000 t and has been declining slowly since 1983 (Table 2.1; Fig. 2.6). Stock levels in 1986 are similar to 1985 but the encouraging recruitment observed in the south coast was not evident in this area.

The forecasts for the south coast stocks are brighter than for the last few years. The northern Strait of Georgia forecast with average and good recruitment is for 37,500 and 49,100 t. (Table 2.6) These levels are similar to the long term average for this stock although lower than levels reached in the late 1970s (Table 2.2; Fig. 2.7). The southern Strait of Georgia forecast is for 8,700 t with average recruitment and only 6,900 t with poor. The long term trend in this stock has been downward and it is now approaching the levels of the late 1960s. Caution is warranted in the consideration of any fisheries for this area.

The stock on the southern west coast of Vancouver Island is continuing the upward trend begun in 1984 (Table 2.2; Fig. 2.7). The forecasts with average and good recruitments are for 26,600 and 39,200 t, respectively (Table 2.6). Even a poor recruitment should see a minimum of 21,900 t in this area during 1987. The prognosis for the northern west coast of Vancouver Island is not as clear due primarily to the mixed coverage obtained by spawn surveys here in the last few years. Stock levels appear to be near the long term average and have increased substantially over 1985 (Table 2.2). Forecasts with poor and average recruitment are for 9,200 and 13,100 t, respectively. The strong showing of the major stocks on the south

coast indicates the potential for substantial fisheries in these areas during 1987.

The minor and resident stock estimates are found in Tables 2.3 to 2.5. The abundance trends generally follow those in the nearby major assessment areas. No areas that could support substantial fisheries are readily evident. The stocks on the west coast of the Queen Charlotte Islands are in obvious decline. The minor stocks in the central coast areas are apparently not surveyed with sufficient regularity to make it possible to discern trends, but no major increases are evident. The Johnstone Strait stocks are also quite variable and although the long term trend has been downward, some of these could potentially support an impoundment or spawn-on-kelp operation.

Table 2.1. Estimates of spawning biomass, catch, and total stock abundance (tonnes) for the northern stock assessment regions for 1951-1986 from the escapement model.

	Queen Charlotte Is.			North Coast			Central Coast		
Year	Spawners	Catch	Stock	Spawners	Catch	Stock	Spawners	Catch	Stock
51	3315.	2847.	6162.	21009.	45865.	66874.	13130.	40558.	53688.
52	2353.	10147.	12500.	7584.	52262.	59847.	6256.	26305.	32561.
53	4526.	0.	4526.	10706.	1981.	12688.	13576.	768.	14344.
54	9145.	1786.	10931.	7866.	27277.	35142.	12082.	20740.	32822.
55	4717.	498.	5215.	10067.	17806.	27873.	11179.	12263.	23443.
56	4369.	77549.	81917.	9813.	10182.	19995.	8850.	40885.	49736.
57	1202.	23247.	24449.	15303.	23254.	38556.	3929.	22892.	26821.
58	627.	11147.	11775.	6466.	9304.	15770.	4979.	7330.	12310.
59	5617.	6828.	12445.	12472.	7382.	19854.	6429.	26111.	32541.
60	2756.	0.	2756.	10281.	21304.	31585.	13998.	2170.	16168.
61	5140.	576.	5716.	10925.	42750.	53675.	6733.	28208.	34941.
62	3471.	7711.	11182.	15973.	27664.	43637.	17603.	16627.	34230.
63	3569.	14705.	18274.	11869.	40218.	52087.	9775.	41439.	51214.
64	2551.	26594.	29145.	12704.	28729.	41433.	8329.	34527.	42856.
65	1172.	32550.	33722.	4926.	40842.	45768.	4827.	14358.	19185.
66	2799.	2746.	5545.	4464.	19617.	24081.	3824.	29470.	33294.
67	586.	161.	747.	2286.	9577.	11862.	7153.	17048.	24201.
68	566.	80.	646.	4621.	3162.	7783.	7173.	910.	8083.
69	1417.	0.	1417.	699.	416.	1115.	3055.	100.	3155.
70	2210.	0.	2210.	9119.	1362.	10481.	15145.	209.	15354.
71	3335.	0.	3335.	7522.	3844.	11366.	6287.	3401.	9689.
72	2197.	1260.	3457.	8376.	4494.	12870.	6536.	9171.	15707.
73	1864.	2231.	4094.	8655.	1607.	10262.	18488.	7799.	26287.
74	5467.	2277.	7744.	6794.	3819.	10614.	15525.	8849.	24375.
75	3103.	4408.	7511.	8280.	1702.	9982.	14906.	8739.	23645.
76	7146.	9425.	16570.	12314.	4307.	16621.	23324.	12199.	35523.
77	8835.	10024.	18859.	11550.	8142.	19692.	21837.	11074.	32910.
78	7774.	9489.	17263.	5568.	8588.	14156.	12973.	13970.	26943.
79	5926.	8018.	13945.	10543.	4317.	14860.	10850.	5.	10855.
80	18675.	2274.	20950.	12669.	3425.	16094.	23330.	528.	23858.
81	17932.	5631.	23562.	13026.	3090.	16115.	25532.	2573.	28104.
82	15075.	3778.	18853.	10863.	1984.	12847.	26002.	6370.	32372.
83	13121.	5597.	18717.	19565.	0.	19565.	31996.	4677.	36673.
84	15232.	4719.	19950.	20725.	3761.	24486.	21668.	3890.	25557.
85	11958.	6109.	18066.	21640.	6747.	28387.	17947.	5209.	23156.
86	4393.	3573.	7966.	24292.	8523.	32815.	15214.	2825.	18039.

Table 2.2. Estimates of spawning biomass, catch, and total stock abundance (tonnes) for the southern stock assessment regions for 1951-1986 from the escapement model.

	Georgia Strait - N			Georgia Strait - S			WCVI - South			WCVI - North		
Year	Spawners	Catch	Stock	Spawners	Catch	Stock	Spawners	Catch	Stock	Spawners	Catch	Stock
51	23665.	17513.	41178.	2880.	25892.	28772.	4932.	15914.	20845.	9695.	6117.	15812.
52	21715.	20670.	42385.	10704.	25306.	36010.	4802.	10630.	15431.	2498.	16415.	18913.
53	25789.	7875.	33665.	37649.	755.	38404.	6955.	20.	6975.	18548.	0.	18548.
54	16871.	20380.	37251.	26441.	45040.	71481.	4046.	30620.	34666.	8366.	8875.	17240.
55	23539.	26158.	49698.	23321.	41752.	65073.	4840.	6247.	11087.	7773.	6524.	14297.
56	10114.	26832.	36947.	11711.	43768.	55479.	6619.	17098.	23717.	9989.	508.	10497.
57	9761.	20767.	30528.	5119.	36109.	41228.	4672.	4402.	9074.	14119.	491.	14610.
58	6060.	10325.	16385.	13114.	14459.	27573.	8637.	11520.	20156.	5610.	43.	5653.
59	12012.	35697.	47710.	12756.	14031.	26786.	4573.	37704.	42278.	4226.	32370.	36597.
60	15192.	22254.	37445.	7365.	45489.	52854.	4174.	17652.	21826.	2935.	38145.	41080.
61	12660.	7217.	19877.	7202.	27249.	34451.	5978.	13444.	19422.	4203.	17356.	21559.
62	12424.	31522.	43946.	4222.	33851.	38073.	6852.	31275.	38127.	10055.	12777.	22832.
63	12132.	37310.	49442.	6666.	34552.	41218.	6574.	26173.	32747.	3080.	17230.	20311.
64	11629.	35892.	47521.	5120.	40464.	45584.	12888.	31174.	44062.	6518.	1914.	8432.
65	10359.	28165.	38524.	1876.	22998.	24873.	5196.	34890.	40086.	6994.	4741.	11735.
66	3662.	20974.	24636.	2047.	13586.	15633.	2531.	25708.	28239.	2125.	4207.	6332.
67	5198.	11280.	16478.	1899.	19883.	21782.	1572.	23536.	25108.	3657.	6260.	9917.
68	5416.	908.	6324.	3955.	983.	4938.	3147.	1711.	4858.	2724.	0.	2724.
69	7116.	288.	7404.	5619.	401.	6020.	4200.	0.	4200.	6727.	0.	6727.
70	17236.	614.	17849.	9728.	384.	10112.	12971.	0.	12971.	6501.	0.	6501.
71	20914.	946.	21860.	7905.	745.	8650.	13621.	0.	13621.	6422.	0.	6422.
72	10793.	5814.	16607.	6732.	2368.	9100.	13499.	4285.	17784.	9921.	2609.	12530.
73	11555.	6585.	18140.	7349.	970.	8319.	4644.	10409.	15053.	8492.	7894.	16385.
74	21701.	3210.	24911.	12071.	791.	12863.	10001.	6371.	16372.	4156.	10489.	14645.
75	26524.	5114.	31638.	13029.	1063.	14093.	15811.	18593.	34405.	8654.	7515.	16169.
76	29419.	8163.	37582.	7209.	4075.	11283.	21492.	33441.	54933.	4145.	5520.	9666.
77	35284.	11304.	46588.	4185.	6205.	10390.	22049.	26453.	48502.	5088.	3688.	8777.
78	39770.	13805.	53575.	10316.	10129.	20444.	14202.	18105.	32307.	12874.	4846.	17720.
79	56231.	8638.	64869.	15007.	11699.	26706.	20534.	9876.	30411.	26610.	9510.	36120.
80	41089.	4414.	45502.	9012.	1294.	10306.	19621.	2276.	21897.	23613.	2226.	25838.
81	23574.	7375.	30948.	9167.	4645.	13812.	18226.	4928.	23154.	9484.	3833.	13317.
82	45860.	5705.	51564.	5739.	7086.	12826.	8584.	3110.	11694.	10704.	2947.	13651.
83	24177.	16220.	40397.	8696.	949.	9644.	8103.	6141.	14243.	9230.	2597.	11827.
84	11682.	9869.	21552.	8585.	1175.	9760.	12128.	5718.	17846.	4497.	1032.	5529.
85	11338.	6228.	17565.	4297.	791.	5088.	20348.	178.	20526.	2929.	0.	2929.
86	37164.	0.	37164.	7049.	0.	7049.	25572.	0.	25572.	10547.	0.	10547.

Table 2.3 Estimates of total biomass and average reduction and roe fishery catches (tonnes) for minor and resident stocks in the Queen Charlotte Islands for 1951-1986 from the escapement model.

	Section						Total	Section	
Season	001	002	003	004	005	006	Area 2W	022	023
51	0.	0.	0.	0.	0.	0.	0.	628.	0.
52	0.	0.	0.	0.	0.	0.	0.	354.	0.
53	0.	0.	625.	130.	0.	0.	755.	1460.	0.
54	0.	0.	0.	0.	0.	0.	0.	25019.	0.
55	0.	0.	0.	0.	0.	0.	0.	19753.	0.
56	0.	0.	0.	0.	0.	0.	0.	5931.	93.
57	0.	0.	138.	0.	0.	464.	602.	1183.	0.
58	0.	0.	178.	0.	26.	0.	204.	83.	0.
59	1345.	924.	1287.	0.	825.	858.	5239.	11245.	0.
60	74.	527.	1102.	0.	88.	2707.	4498.	3493.	0.
61	881.	319.	407.	0.	293.	1662.	3562.	3823.	0.
62	319.	1530.	1261.	0.	230.	770.	4110.	7892.	0.
63	0.	1939.	0.	0.	0.	0.	1939.	2953.	0.
64	404.	1002.	612.	145.	118.	3502.	5783.	3642.	0.
65	285.	0.	245.	81.	1383.	3361.	5355.	5950.	0.
66	0.	40.	16.	0.	183.	0.	239.	3659.	0.
67	63.	803.	0.	0.	125.	62.	1053.	755.	140.
68	0.	5.	83.	0.	59.	55.	202.	214.	0.
69	16.	185.	258.	0.	751.	0.	1210.	848.	0.
70	0.	326.	283.	0.	629.	322.	1560.	985.	3796.
71	0.	103.	629.	0.	425.	1465.	2622.	1672.	5122.
72	0.	319.	363.	0.	1606.	2798.	5086.	2791.	6268.
73	0.	84.	1190.	0.	1903.	4287.	7464.	932.	8465.
74	0.	0.	1171.	0.	2389.	3191.	6751.	1383.	5800.
75	0.	239.	1215.	204.	1261.	4779.	7698.	1734.	4564.
76	0.	317.	384.	0.	1468.	7612.	9781.	2452.	4476.
77	0.	184.	489.	134.	1974.	4755.	7536.	2452.	3134.
78	519.	0.	1525.	0.	1848.	3264.	7156.	3039.	2704.
79	1025.	30.	543.	54.	811.	775.	3238.	1309.	2737.
80	873.	1041.	1374.	0.	1838.	2419.	7545.	31.	0.
81	646.	2843.	1512.	247.	1004.	797.	7049.	519.	1580.
82	0.	4906.	2839.	352.	3466.	1643.	13206.	755.	407.
83	194.	2716.	3464.	427.	4420.	1036.	12257.	464.	1309.
84	470.	2033.	869.	0.	1668.	573.	5613.	1818.	1382.
85	0.	1707.	680.	22.	1533.	810.	4752.	334.	893.
86	0.	767.	207.	0.	1099.	0.	2073.	1200.	629.
Avg. biomass	198	691	693	50	928	1499	4059	3410	1486
Avg. catch (1951-67)	33	0	6	0	63	318	420	4983	5
Avg. catch (1972-86)	0	13	152	0	337	709	1212	182	1020

Table 2.4. Estimates of total biomass and average reduction and roe fishery catches (tonnes) for minor and resident stocks in the Central Coast for 1951-1986 from the escapement model.

	Section										Area	Area	
Season	061	062	063	064	065	066	081	082	083	084	9	10	Total
51	1323.	0.	9.	105.	0.	1536.	0.	0.	7.	0.	745.	142.	3867.
52	6673.	0.	0.	88.	211.	0.	2374.	0.	7.	0.	542.	52.	9947.
53	98.	0.	0.	0.	0.	0.	0.	0.	0.	0.	153.	488.	739.
54	1212.	0.	0.	864.	223.	47.	599.	162.	971.	0.	2167.	434.	6679.
55	1812.	30.	95.	2905.	2118.	113.	1026.	8.	273.	201.	2473.	1387.	12441.
56	271.	0.	37.	12.	989.	5.	172.	0.	307.	14.	157.	113.	2077.
57	5289.	0.	17.	41.	1983.	0.	1476.	28.	763.	0.	2628.	1624.	13849.
58	2207.	0.	14.	0.	324.	0.	0.	0.	1753.	0.	473.	295.	5066.
59	1796.	233.	674.	44.	65.	241.	75.	0.	1134.	0.	2364.	1199.	7825.
60	1619.	310.	2508.	242.	1644.	0.	406.	0.	330.	20.	396.	566.	8041.
61	2396.	128.	663.	7.	3665.	0.	321.	33.	457.	0.	897.	752.	9319.
62	2269.	261.	90.	0.	5055.	138.	6950.	0.	20.	0.	2028.	1347.	18158.
63	2322.	965.	1282.	181.	65.	0.	2556.	0.	1169.	0.	1300.	196.	10036.
64	1453.	938.	2117.	0.	934.	31.	1827.	269.	953.	529.	3467.	686.	13204.
65	3718.	256.	134.	0.	656.	0.	454.	0.	673.	129.	817.	304.	7141.
66	12579.	663.	572.	277.	37.	59.	2693.	1550.	822.	473.	3740.	820.	24285.
67	4886.	131.	129.	117.	191.	0.	810.	103.	270.	893.	3882.	1319.	12731.
68	1570.	0.	44.	1.	0.	0.	0.	0.	913.	33.	1577.	235.	4373.
69	0.	0.	4.	25.	0.	0.	0.	176.	12.	0.	87.	36.	340.
70	27.	0.	53.	47.	11.	0.	0.	522.	211.	5.	1229.	254.	2359.
71	60.	0.	33.	11.	22.	0.	0.	203.	379.	150.	520.	684.	2062.
72	0.	0.	9.	0.	0.	354.	0.	130.	330.	185.	962.	1135.	3105.
73	0.	59.	27.	0.	0.	0.	0.	114.	105.	1069.	3260.	106.	4740.
74	0.	30.	28.	0.	0.	0.	0.	39.	92.	547.	974.	272.	1982.
75	0.	0.	29.	0.	4.	0.	24.	272.	79.	1068.	691.	277.	2444.
76	0.	130.	0.	0.	22.	0.	211.	84.	100.	762.	616.	160.	2085.
77	0.	0.	19.	0.	2.	0.	0.	0.	92.	383.	480.	43.	1019.
78	57.	0.	2.	0.	0.	0.	0.	23.	43.	191.	304.	160.	780.
79	0.	154.	0.	0.	0.	131.	0.	0.	25.	168.	75.	61.	614.
80	0.	0.	0.	0.	0.	459.	0.	0.	83.	0.	177.	178.	897.
81	426.	19.	0.	0.	0.	0.	0.	0.	52.	83.	37.	130.	747.
82	559.	0.	0.	0.	0.	0.	0.	0.	25.	0.	623.	570.	1777.
83	85.	90.	0.	0.	0.	0.	0.	0.	11.	98.	138.	417.	839.
84	0.	0.	0.	0.	0.	0.	0.	0.	18.	205.	33.	537.	793.
85	1519.	31.	0.	0.	0.	0.	0.	0.	0.	50.	89.	170.	1859.
86	704.	519.	0.	0.	0.	0.	0.	0.	44.	34.	1191.	456.	1757.
Avg. biomass	1581	137	239	138	506	87	610	103	348	203	1114	489	5555
Avg. catch (1951-67)	2934	216	446	254	1008	59	1207	119	595	93	1509	541	8980
Avg. catch (1972-85)	50	0	0	0	0	0	16	0	0	141	238	103	547

Table 2.5. Estimates of total biomass and average reduction and roe fishery catches (tonnes) for minor and resident stocks in Johnstone Strait for 1951-1986 from the escapement model.

Season	Area 11	Section 126	Section 127	Other Area 12	Other Area 13	Total
51	1.	945.	297.	3035.	111.	4389.
52	3.	1618.	314.	6144.	66.	8145.
53	0.	151.	203.	1037.	131.	1522.
54	2.	847.	344.	5045.	383.	6621.
55	6613.	322.	1027.	1019.	1108.	10089.
56	257.	535.	152.	245.	527.	1716.
57	10.	618.	99.	12904.	63.	13694.
58	12.	21.	155.	4103.	36.	4327.
59	111.	2994.	1062.	1972.	288.	6427.
60	626.	939.	2567.	5386.	1587.	11105.
61	209.	816.	282.	1604.	3144.	6055.
62	773.	107.	749.	9841.	363.	11833.
63	2187.	591.	1039.	5793.	1199.	10809.
64	62.	411.	5698.	8858.	2129.	17158.
65	1271.	996.	2937.	12531.	4058.	21793.
66	1171.	267.	2075.	14077.	796.	18386.
67	244.	129.	986.	13570.	3292.	18221.
68	5.	38.	117.	5667.	4.	5831.
69	16.	152.	133.	1127.	175.	1603.
70	38.	231.	183.	2099.	142.	2693.
71	54.	119.	57.	1333.	386.	1949.
72	23.	1470.	875.	3841.	1274.	7483.
73	9.	1099.	2824.	8671.	328.	12931.
74	5.	528.	2921.	1616.	234.	5304.
75	23.	1039.	2589.	1516.	719.	5886.
76	25.	1074.	1712.	693.	187.	3691.
77	12.	324.	1274.	1063.	139.	2812.
78	12.	523.	487.	236.	261.	1519.
79	45.	44.	40.	167.	263.	559.
80	11.	182.	248.	657.	426.	1524.
81	5.	120.	198.	336.	1068.	1727.
82	0.	102.	421.	61.	2105.	2689.
83	12.	66.	185.	96.	2481.	2840.
84	5.	124.	366.	494.	2.	991.
85	0.	243.	558.	99.	239.	1139.
86	28.	119.	140.	305.	26.	618.
Avg. biomass	393	553	981	2210	826	4963
Avg. catch (1951-67)	734	617	1027	2703	842	5923
Avg. catch (1972-86)	1	292	112	966	112	1482

Table 2.6. Estimates of 1986 spawning biomass and forecasts of age 4+ and recruit biomass in 1987 (thousands of tonnes) from escapement model analysis.

Stock Assessment Region	1986 Spawning Biomass	1987 Forecast			
		Age 4+	Age 3 Recruits		
			poor	average	good
Queen Charlotte Islands Skincuttle-Laskeek	4.4	3.0	0.6	2.5	11.8
Prince Rupert District	24.3	17.0	0.9	4.0	14.9
Central Coast	15.2	10.7	2.1	7.0	19.9
Strait of Georgia North	37.2	26.6	4.8	10.9	22.5
South[a]	7.0	4.9	2.0	3.8	5.1
West Coast Vancouver Island Area 23/24	25.6	19.2	2.7	7.4	20.0
Area 25-27	10.4	7.8	1.4	5.3	15.1

[a]Recruitment estimates are based on data from 1970-1986 due to uncertain stock mixtures during the reduction fishery.

Table 2.7. Statistical models and parameter estimates for the calibration of diver and fishery officer spawn surface survey data.

Model and parameter estimates	R^2	N	F-value	Prob > F
Diver width = 77.87 + 0.80 surface width	60.35	111	165.935	0.0001
Diver width = exp (3.06 + 0.45 $\log_e$ surface width + Area effect)[a]	56.04	111	26.770	0.0001
Eggs/m^2 = exp (5.23 + 0.48 $\log_e$ surface layers)	22.77	111	32.142	0.0001
Eggs/m^2 = 139.95 + 89.05 surface layers[a]	15.20	111	19.536	0.0001

[a]Form of the equations used for the 1985 assessment but with new parameters calculated with the additional 1986 dual survey data points.

Table 2.8. Regression relationships to compare the observed and post calibration values for the equations used in the escapement model.

Model and parameter estimates	R^2	N	F-value	Prob > F
Obs Diver width = 0.0 + 1.00 Adjusted surface width	60.35	111	165.935	0.0001
Obs eggs/m2 = -36.77 + 1.45 Pred eggs/m^2	14.79	111	18.921	0.0001
Obs Tonnage = 111.57 + 0.97 Pred tonnage	48.39	111	102.212	0.0001

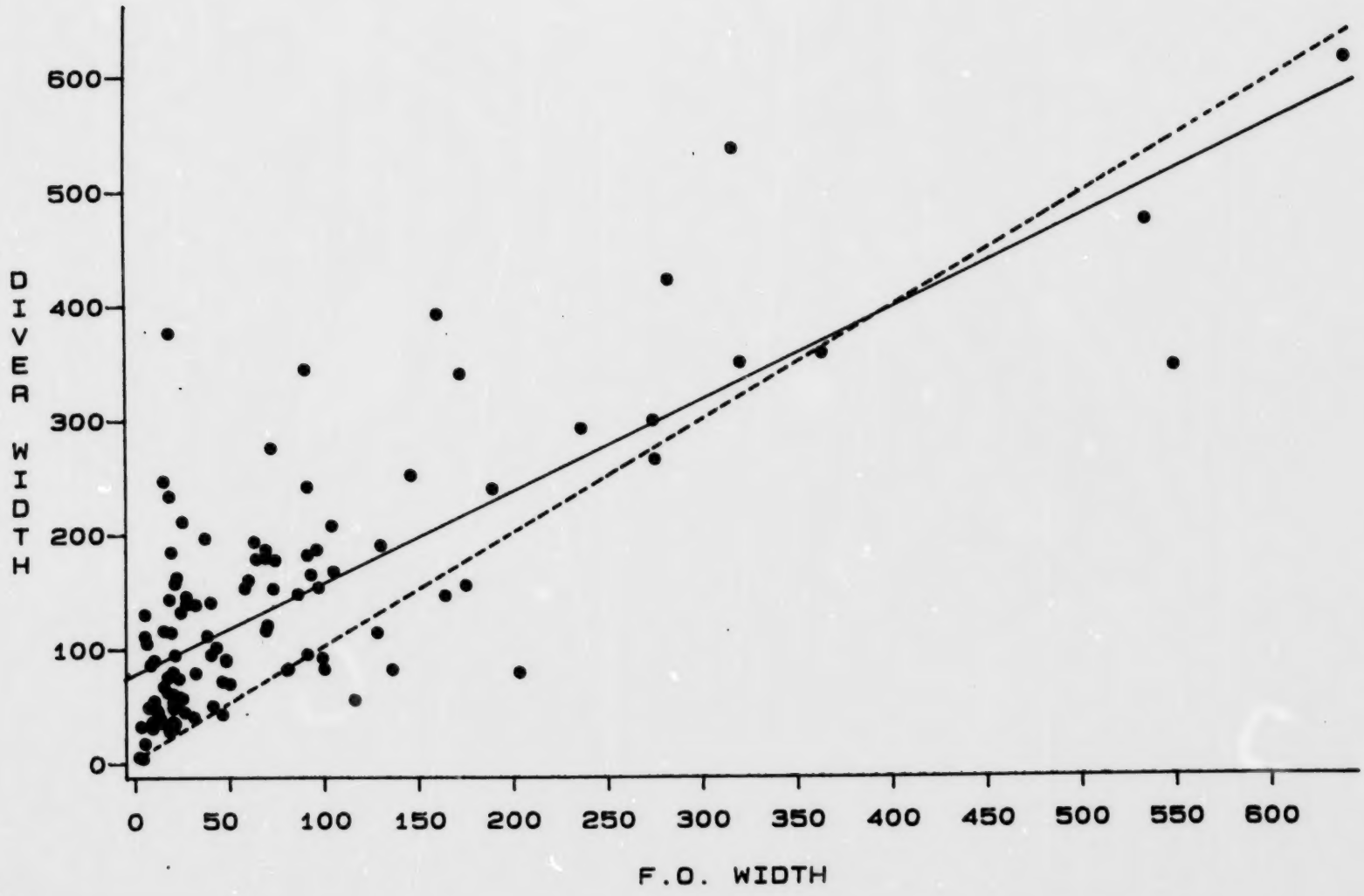

Fig. 2.1. Plot of estimated diver widths versus fishery officer surface widths from dual surveyed spawns. Solid line is the best fit regression to the data. Dashed line represents the 1:1 correspondence of the axes.

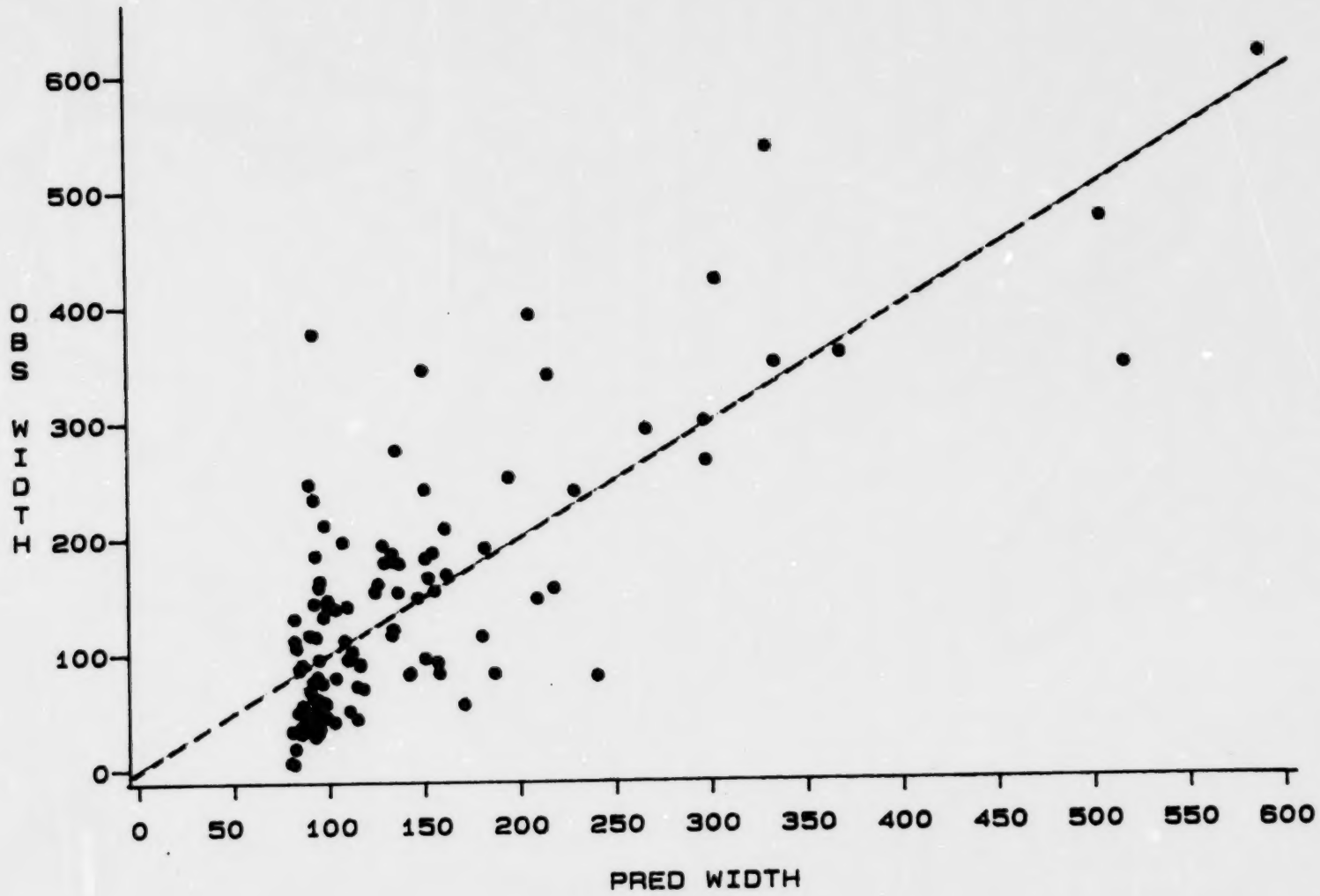

Fig. 2.2. Plot of the observed versus predicted spawn widths. Solid line is the best fit regression to the data. Dashed line represents the 1:1 correspondence of the axes. (Solid and dashed lines are coincident in this figure.)

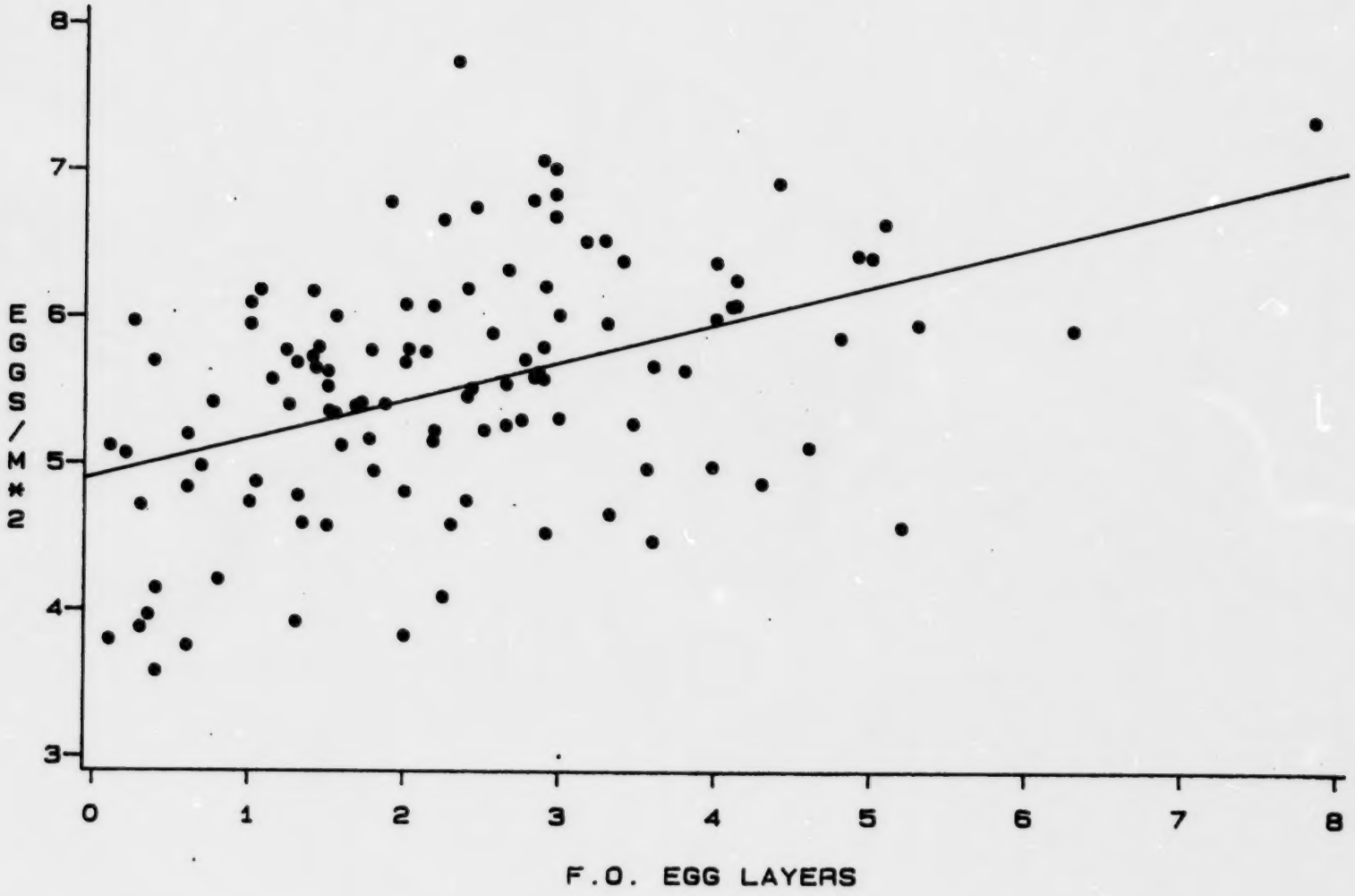

Fig. 2.3. Plot of the average egg density ($x10^5$) for entire spawns from diving surveys versus the mean egg layer estimate for these spawns from the fishery officer surface survey.

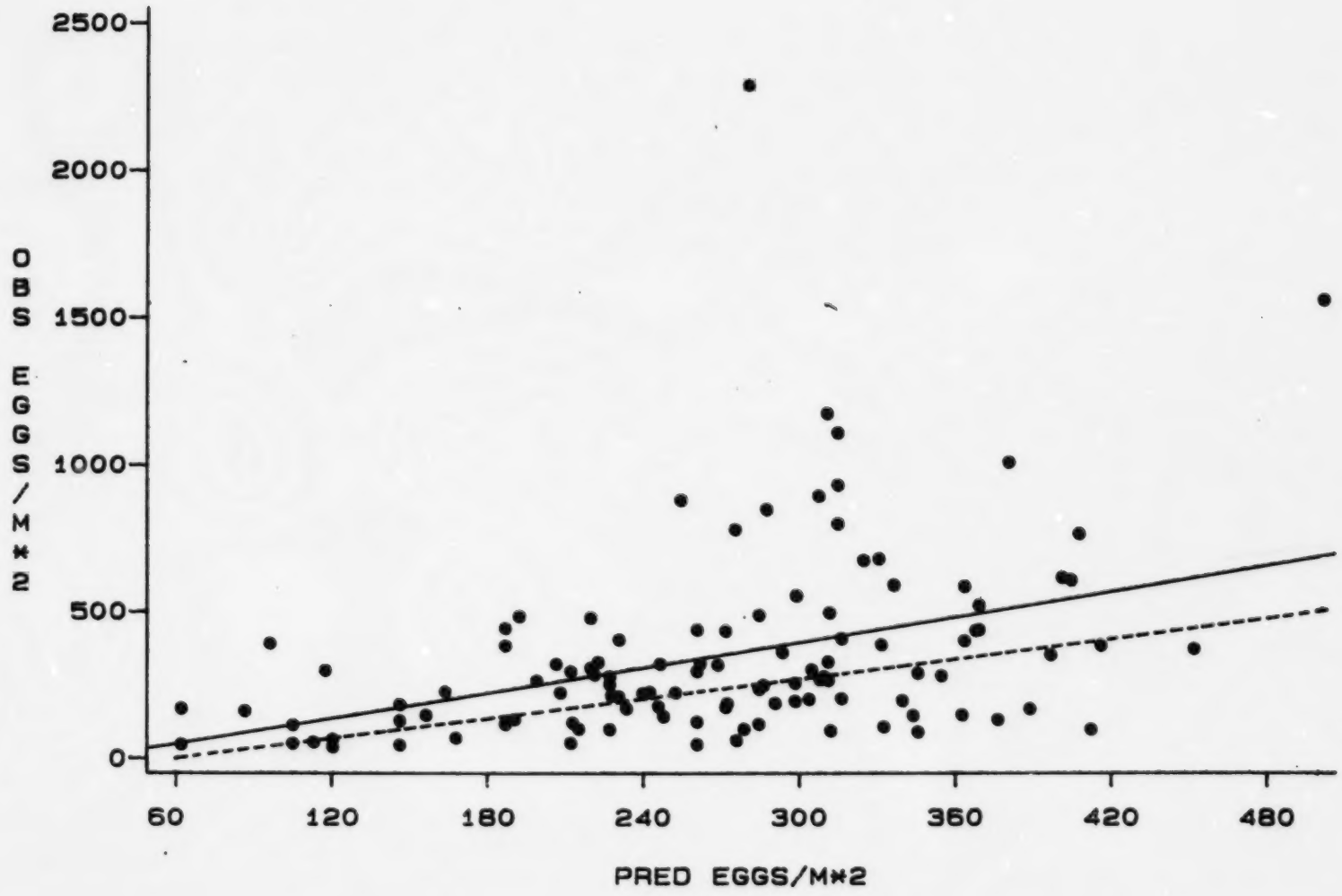

Fig. 2.4. Plot of the observed and predicted egg density ($x10^3$). Solid line is the best fit regression to the data. Dashed line represents the 1:1 correspondence of the axes.

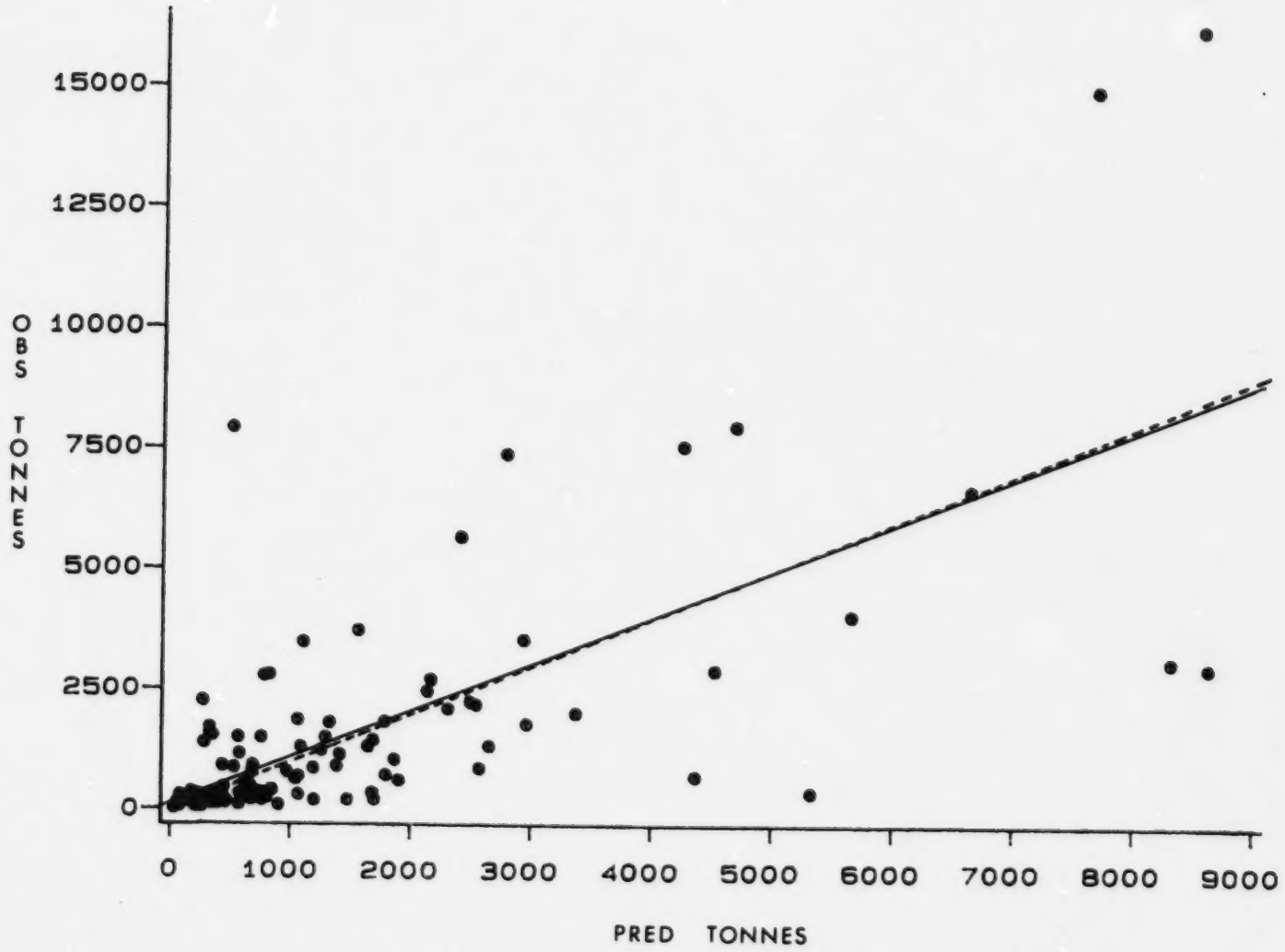

Fig. 2.5. Plot of the observed versus predicted tonnage of spawners. Solid line is the best fit regression to the data. Dashed line represents the 1:1 correspondence of the axes.

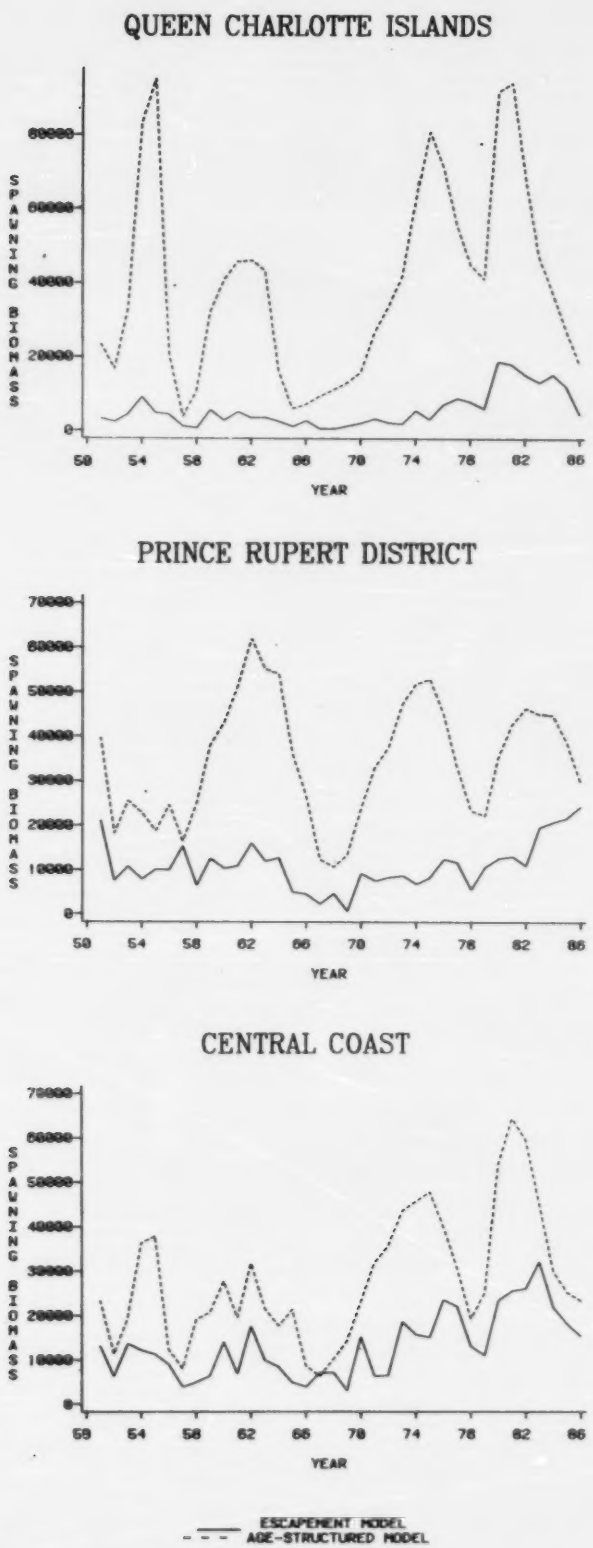

Fig. 2.6. Estimated spawning biomass (tonnes) for the northern stock assessment regions for 1951-1986. Solid line represents escapement model and dashed line age-structured model estimates.

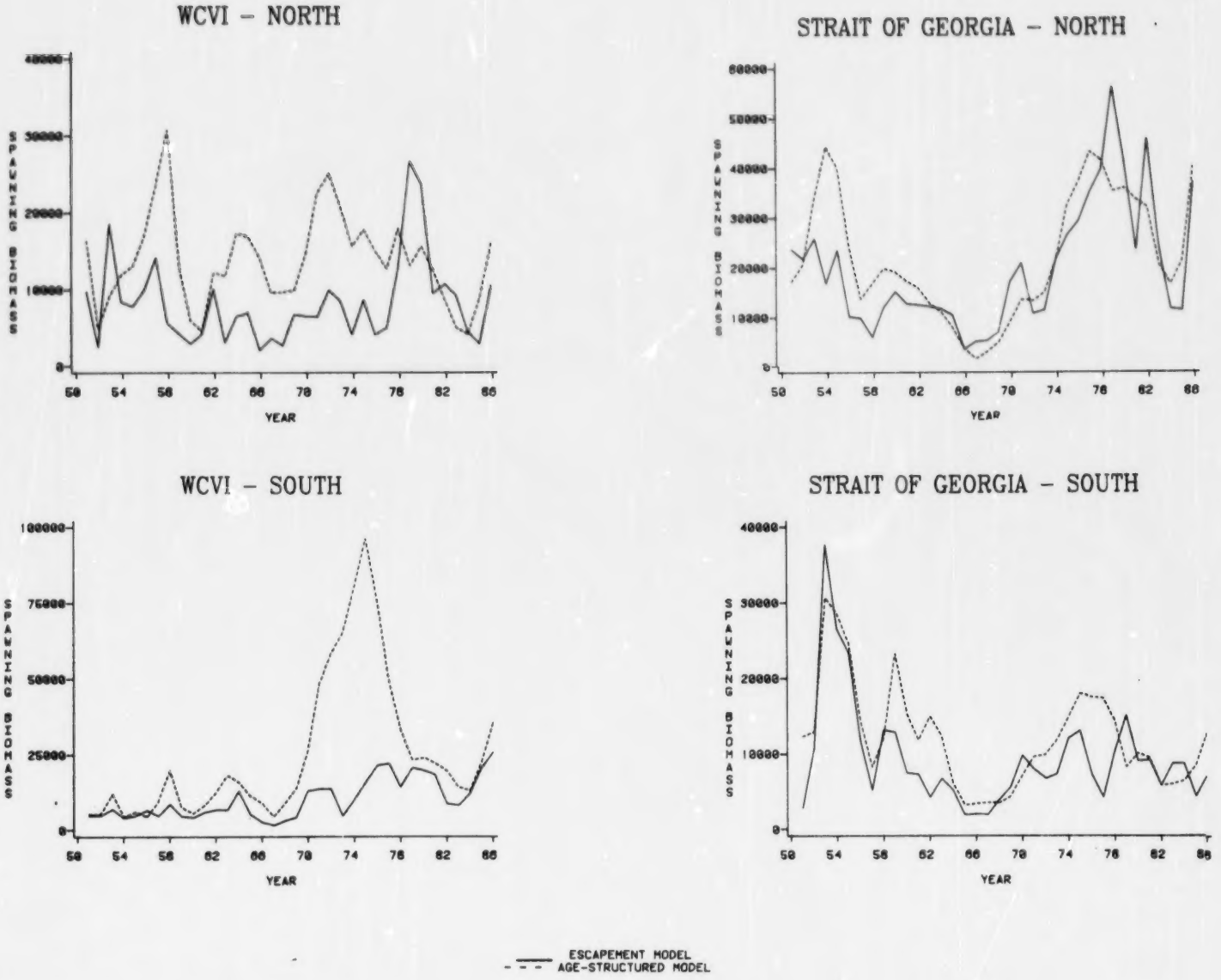

Fig. 2.7. Estimated spawning biomass (tonnes) for the southern stock assessment regions for 1951-1986. Solid line represents escapement model and dashed line age-structured model estimates.

3. AGE-STRUCTURED MODEL

3.1 INTRODUCTION

An age-structured model has been used to assess B.C. herring stocks since 1982 (Stocker et al. 1983); this model is a modified version of the one described in Fournier and Archibald (1982). The major differences in the version used to assess B.C. herring stocks are the incorporation of spawn survey data and the reparameterization of the catch equations to separate gillnet and seine fisheries. The model includes realistic assumptions about the form of both measurement and process errors. A maximum likelihood method is used to simultaneously estimate all model parameters.

The use of the age-structured model to assess B.C. herring stocks is an ongoing process of refining the model so that it is more consistent with the life history of B.C. herring and with the fisheries being analyzed. A major change to the model used for the 1986 stock assessments is the reparameterization of the catch equations to include an availability term.

3.2 METHODS

The age-structured model used for herring assessments has been described in detail elsewere (Haist et al. 1986, Stocker et al. 1985); only changes to model parameterization are described here. Two types of fishing gear are commonly used in B.C.'s herring fisheries. Of these, seine nets are assumed to be non-selective for size given fish beyond the juvenile stages. Gillnets are highly selective for larger, older fish. Given that herring fisheries have primarily concentrated on spawning fish, or fish migrating to spawning grounds, the relative availability of age classes to the non-selective gear should be equivalent to the partial recruitment of age-classes to the spawning stock. Because the two gears are temporally separated, with seine fisheries prior to gillnet fisheries, catch equations which separate these fisheries within a season provide a reasonable framework for analyzing the catch-at-age data. The catch equations, including an availabilty term are:

$$C_{ijr} = \frac{F_{ijr}}{(F_{ijr} + M_r)} [1 - \exp(-F_{ijr} - M_r)] \lambda_j \quad N_{ijr}$$

and, for $r = p$

$$N_{ijr+1} \quad N_{ijr} \exp(-F_{ijr} - M_r) + (1 - \lambda_j) N_{ijp} \exp(-M_r)$$

and for $r = p$

$$N_{i+1,j+1,1} = N_{ijp} \exp(-F_{ijp} - M_p) + (1 - \lambda_j) N_{ijp} \exp(-M_p)$$

where C_{ijr} is catch of age class i in year j for fishery r
F_{ijr} is fishing mortality of age class i in year j for fishery r
M_r is natural mortality for fishery r
N_{ijr} is the number of fish in age class i in year j for fishery r
λ_j is the availabilty of age class j
p is the number of fisheries.

A two factor model is used to describe fishing mortality for selective fisheries (ie. gillnet), that is,

$$\log (F_{ijr}) = a_{ir} + b_{jr}$$

where a_{ir} represents the general level of fishing mortality due to fishery r in year i, and b_{jr} represents the relative vulnerability of age class j for fishery r. For non-selective gear the model is

$$\log (F_{ijr}) = a_{ir}.$$

Three fisheries, representing two non-selective and one selective gear type, are included in this year's analysis. The first fishery, covering the winter period, includes the reduction fisheries prior to 1970 and the more recent winter food and bait fisheries. The second and third fisheries are the seine roe and gillnet roe fisheries, respectively.

Since only sexually mature fish are assumed to be available to the fisheries, the availability term is also included in the relationship between actual spawn (AS_i) and the spawn predicted from escapement,

$$AS_i = QSP \sum_j N_{ijp} \exp (-F_{ijp} - M_p) \lambda_j f_j$$

where QSP is a spawn index conversion factor
f_j is the relative fecundity of age class j.

The parameterization of the spawn-recruitment and the actual spawn-observed spawn relationship and associated spawn penalty weights are as described in Haist et al. (1986). Instantaneous natural mortality is assumed to be constant at 0.45 throughout the time series. This is partitioned at 96% for the first fishery and 2% for both the second and third fisheries.

Initial stock reconstructions for the southern Strait of Georgia and northern west coast of Vancouver Island stocks produced unrealistic increases in spawning biomass from 1984 to 1986. This likely results from the high proportion of fish at age 2 observed in recent years in these stocks. To stabilize the reconstructions for these two areas a higher weighting was put on the spawn relationships for the last two years (penalty weight of 500 for both the actual spawn-observed spawn relationship and the actual spawn-escapement relationship, as in Haist et al. 1986). Additionally, deviations were allowed from fishing mortality at age two for the entire time series. These changes to the model parameterization produced a better fit to the observed spawn index data.

Input data used for age-structured model analysis are shown in Appendix Table 1 for all stock groupings. Where no sample data are available, but catches were taken, the catch is included with an alternate fishery for which age-structure data are available. The spawn index is the same as in the 1985 stock assessments. This index sums the lengths of spawnings multipled by a section specific width/intensity factor (Hay and Kronlund 1985).

Forecasts of pre-spawning stock abundance for 1987 are calculated by assuming 96% of the annual natural mortality will occur prior to the roe fisheries. Catches in the winter food and bait fisheries have been minimal in recent years, so removals from this fishery are not considered. The numbers of fish at age prior to the fisheries are then the numbers estimated at the beginning of the 1986/87 season multipled by survival and the estimated availability at age. Recruitment is calculated for three scenarios based on estimated numbers at age 3 for the 1951-86 time series. The exception to this is for the southern Strait of Georgia stock assessment region where historic recruitment is taken only from 1970. Poor, average, and good recruitment are calculated as the mean of the lowest 25%, the middle 50%, and the highest 25% of historic age 3 numbers. Biomass is calculated using the average weights at age for roe seine fisheries over the time series.

3.3 RESULTS

Results from age-structured model stock reconstructions are shown in Appendix Table 2 for the seven major stock assessment regions. Spawning biomass trends are plotted in Figures 2.6 and 2.7. Estimates of spawning biomass in 1986 and forecasts of age 4 and recruit biomass for 1987 are shown in Table 3.1. For the Skincuttle-Laskeek stock, the reconstructions show a major decline in spawning biomass over the past five years. The 1986 spawning biomass is only 20% of the biomass estimated for 1981; a similiar decline is shown in the spawn index over this time period. The age-structured model may overestimate stock size for this area as the estimate of 90,000 t of spawners in 1980 and 1981 is unrealistically high. The forecast for 1987 pre-fishery biomass with poor and average recruitment is 15,300 t and 20,700 t respectively.

For the Prince Rupert District, age-structured analysis shows a slight decline in spawning biomass from 1982 to an estimated 29,500 t of spawners in 1986. This trend is inconsistent with the spawn index which has increased over the same time period. Given average recruitment a run size of 31,300 t is forecast for this area. With good recruitment the forecast stock size is 44,000 t.

The estimated 1986 spawning biomass for the central coast is 23,100 t from age-structured analysis. This represents a significant decline from the 1981 levels, which were estimated as the highest ever. However, the spawn index has shown no major trend over the same time period. Forecast stock abundance for the central coast in 1987 is estimated at 28,3000 t given average recruitment.

Spawning biomass estimates for both the northern and southern Strait

of Georgia indicate significant increases in stock size over the past two years. While this trend is consistent with the observed spawn index for the northern stock, the spawn index for the southern stock shows no significant change over the past four years. As indicated earlier, there appear to be problems with the age-structured analysis for the southern Strait of Georgia because the high proportion of fish at age 2 in recent years leads to overestimation of the size of these cohorts. Forecasts for the northern and southern stocks in 1987, given average recruitment, are 48,400 t and 18,500 t respectively.

Stock reconstructions for the two west coast of Vancouver Island stocks indicate substantial increases in spawning biomass since 1984 when these stocks were at the lowest levels observed since the late 1960's. Forecasts of stock abundance in 1987 for the average recruitment scenario are 40,800 t for the southern stock and 20,700 t for the northern stock.

Table 3.1. Estimates of 1986 spawning biomass and forecasts of age 4+ and recruit biomass in 1987 (thousands of tonnes) from age-structured model analysis.

Stock Assessment Region	1986 Spawning Biomass	1987 Forecast			
		Age 4+	Age 3 Recruits		
			poor	average	good
Queen Charlotte Islands					
Skincuttle-Laskeek	17.7	12.7	2.6	8.0	30.8
Prince Rupert District	29.5	24.8	2.4	6.5	19.2
Central Coast	23.1	20.0	3.5	8.3	20.8
Strait of Georgia					
North	40.3	38.0	4.8	10.4	20.7
South	12.7	11.0	2.4	7.5	20.5
West Coast Vancouver Island					
Area 23/24	35.3	32.1	4.3	8.7	22.2
Area 25-27	16.0	15.3	1.7	5.4	10.5

4. CATCH RECOMMENDATIONS

We recommend catch levels at 20% of the "best" forecasts of the 1987 pre-fishery stock biomass for those stocks that are well above CUTOFF levels. The 20% harvest rate is based on an analysis of stock dynamics which indicates this level will stabilize both catch and spawning biomass while foregoing minimal yield over the long term. While a fixed escapement policy would provide the theoretical optimal solution, that is, highest yields and stock stability, this policy is not attainable at the operational level. For stocks that are marginally above CUTOFF we recommend the following catch:

Catch = Weighted Run - CUTOFF

This will provide for smaller fisheries for areas where the 20% harvest rate would bring the escapement down to dangerously low levels.

CUTOFF levels are established at one-forth of the unfished equilibrium biomass. The unfished equilibria were estimated using computer simulations. For the seven stock assessment regions the following CUTOFF levels have been estimated:

Queen Charlotte Islands	13,100 t
Prince Rupert District	8,900 t
Central Coast	11,100 t
Strait of Georgia-north	14,600 t
Strait of Georgia-south	6,200 t
W.C. Vancouver Is.-south	15,400 t
W.C. Vancouver Is.-north	6,000 t

To determine the "best" stock forecasts we used a two step procedure. First, for each of the two assessment methods, and for each stock grouping, one recruitment scenario (i.e. poor, average, or good) was chosen. The information used to choose a particular recruitment scenario includes both the forecast year class strength from either a stock-environment-recruitment model or time-series model (Stocker 1986) and recent trends in stock and recruitment levels. Secondly, we assigned subjective probabilities to the two alternative assessment methods. Based on intuition and past performance, we believe that the age-structured model makes the most likely predictions of forecast runs. However the escapement method incorporates diving survey information for most major spawns in 1986, and we feel this direct measure of egg deposition should be a reasonably accurate estimate of current stock levels. Therefore, we assigned equal subjective probabilities to the two models for all areas in which we did not have additional information to discount one of the methods. Because of the problem with the assessment of spawn on Macrocystis using surface surveys, and the lack of diving surveys in the Queen Charlotte Islands, we discounted the forecast from the escapement method for this area. Additionally, we felt that the age-structured model results may contain bias for the southern Strait of Georgia and northern west coast of Vancouver Island stock assessment regions because additional model constraints were required to obtain reasonable stock reconstructions for these areas. Accordingly, for these three areas we used a 80:20 weighting in favour of the preferred model.

The assigned probabilities were used to weight the forecast "best" runs obtained from each method to provide a single "weighted run" for each of the stock groupings (Table 4.1).

The predicted level of recruitment to the Queen Charlotte Islands stock assessment regions was average from a stock-environment-recruitment model (Stocker 1986). However, because this stock has decreased steadily since 1981 and all recruiting year classes have been below average since the strong 1977 year-class, the assumption of average recruitment may be optimistic. Therefore the midway point between poor and average recruitment was chosen giving a weighted forecast of 15,300 t. This forecast is only marginally above the CUTOFF, so we recommend a catch level of 2,210 t for the Queen Charlotte Islands.

An average level of recruitment is predicted for the Prince Rupert District, however, given the steady increase in spawning stock and observed average to good recruitments in recent years, a slightly more optimistic recruitment assumption may be warranted. Therefore, we use a recruitment level midway between average and good for a weighted forecast of 32,050 t. The recommended catch is then 6,410 t for the Prince Rupert district.

For the central coast migratory stock the weighted run is forecast at 23,000 t with average recruitment. This represents an increase over 1986 and a recommended catch of 4,600 t. The above average recruitment in the south appears to have favourably affected the production of the central coast stock, however, recruitment in the latter stock is not expected to exceed average.

The south coast stocks have rebounded dramatically in 1986 and recruitment is forecast to be average in all areas for 1987. The weighted forecasts for the Strait of Georgia are 42,950 and 10,000 t in the northern and southern areas. The forecast in the southern stock uses an 80:20 weighting in favour of the escapement model and relies on recruitment information for the roe fishing period only. The recommended catches are 8,590 and 2,000 t for the northern and southern stocks, respectively. It is also recommended that the latter catch be taken in the fall food fishery, if possible.

The weighted forecast run to the west coast of Vancouver Island stock is 33,700 t in the southern area and 14,620 t to the northern area. This provides recommended catch levels of 6,740 and 2,920 t, respectively.

The catch levels recommended in this summary are based purely on biological considerations, reflecting the best biological analyses given the available data bases. We point out that management of the various fisheries has practical constraints other than the biological considerations discussed in this report. Furthermore, there are certain economic considerations which we do not regard when making recommendations. Thus, the quotas ultimately adopted by DFO may differ from those recommended herein. It should also be noted that the catch levels adopted by DFO include all fisheries. Catches from food, bait, and special fisheries are subtracted from the recommended catch levels to determine the roe herring quotas.

Table 4.1. Summary of spawning biomass in 1986 and forecasts of stock biomass in 1987 (thousands of tonnes) from age-structured (AS) and escapement (ESC) models and weighted runs for poor, average, and good recruitment levels.

	Method												
	Age-structured model				Escapement Model					Weighted Results			
		Forecast stock with recruitment				Forecast stock with recruitment				Forecast stock with recruitment			
	1986 spawners	poor	avg.	good	1986 spawners	poor	avg.	good	Weighting AS:ESC	poor	avg.	good	Recommended Catch
Queen Charlotte Islands Skincuttle-Selwyn	17.7	15.3	20.7	43.5	4.4	3.6	5.5	14.8	.8:.2	12.96	17.66	37.76	2.21[a]
Prince Rupert District	29.5	27.2	31.3	44.0	24.3	17.9	21.0	31.9	.5:.5	22.55	26.15	37.95	6.41[b]
Central Coast migratory stock	23.1	23.5	28.3	40.8	15.2	12.8	17.7	30.6	.5:.5	18.15	23.00	35.70	4.60[c]
Strait of Georgia northern stock	40.3	42.8	48.4	58.7	37.2	31.4	37.5	49.1	.5:.5	37.10	42.95	53.90	8.59[c]
southern stock	12.7	13.4	15.2	17.6	7.0	6.9	8.7	10.0	.2:.8	8.20	10.00	11.52	2.00[c]
West Coast Vancouver Island southern stock	35.3	36.4	40.8	54.3	25.6	21.9	26.6	39.2	.5:.5	29.15	33.70	46.75	6.74[c]
northern stock	16.0	17.0	20.7	25.8	7.3	9.2	13.1	22.9	.2:.8	10.76	14.62	23.48	2.92[c]

[a]Recommended catch is difference between forecast stock biomass and CUTOFF assuming recruitment level midway between poor and average.
[b]Recommended catch is 20% of forecast stock biomass assuming recruitment midway between average and good.
[c]Recommended catch is 20% of forecast stock biomass assuming average recruitment.

5. REFERENCES

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APPDENIX TABLES

Appendix Table 1.1. Age composition and catch in numbers by fishery and season and weight at age averaged over all seasons for the Skincuttle-Laskeek stock assessment region. Data are used for age-structured model analysis.

SEASON	FISHERY	PERCENT AT AGE 1	2	3	4	5	6	7	8	9	10	NUMBER AGED	SAMPLE WEIGHT	CATCH ($\times 10^{-6}$)
1950/51	REDUCTION	0.0	0.1	15.3	52.9	15.3	11.5	4.2	0.6	0.1	0.0	1476	400	31.74
1951/52	REDUCTION	1.2	16.9	21.5	33.8	21.3	4.1	1.1	0.1	0.0	0.0	2251	400	113.65
1953/54	REDUCTION	0.0	0.0	38.2	38.2	8.8	11.8	0.0	2.9	0.0	0.0	0[a]	25	16.78
1954/55	REDUCTION	0.0	4.3	8.5	43.8	16.3	19.6	6.8	0.6	0.0	0.0	0[a]	25	4.26
1955/56	REDUCTION	0.0	0.1	16.0	9.6	62.2	8.4	2.7	0.7	0.0	0.1	1348	400	655.92
1956/57	REDUCTION	0.2	21.1	23.7	15.7	9.5	26.9	2.3	0.4	0.1	0.0	4651	400	223.51
1957/58	REDUCTION	0.0	81.9	16.4	1.2	0.2	0.1	0.1	0.0	0.0	0.0	2838	400	214.62
1958/59	REDUCTION	0.0	1.1	63.2	28.4	7.4	0.0	0.0	0.0	0.0	0.0	95	25	73.57
1960/61	REDUCTION	0.0	0.0	26.0	52.0	22.0	0.0	0.0	0.0	0.0	0.0	50	25	5.25
1961/62	REDUCTION	0.0	3.0	37.6	41.4	9.6	6.5	1.6	0.2	0.0	0.0	428	400	70.10
1962/63	REDUCTION	0.0	0.4	50.0	27.1	18.2	2.1	2.0	0.0	0.1	0.1	804	400	134.23
1963/64	REDUCTION	0.0	0.9	15.3	59.5	17.8	5.3	1.1	0.0	0.0	0.0	528	400	232.68
1964/65	REDUCTION	0.0	1.9	75.7	13.3	5.2	2.2	1.1	0.5	0.0	0.0	1149	400	318.45
1965/66	REDUCTION	3.3	27.0	38.7	17.8	6.4	2.4	1.8	1.3	0.7	0.5	0[a]	25	32.36
1966/67	REDUCTION	0.0	0.9	67.3	26.5	2.7	2.7	0.0	0.0	0.0	0.0	0[a]	25	1.73
1967/68	REDUCTION	0.8	29.7	50.2	17.1	2.2	0.0	0.0	0.0	0.0	0.0	0[a]	25	1.01
1971/72	ROE-SN	0.0	4.7	37.6	46.5	4.5	4.5	1.5	0.4	0.2	0.0	465	400	9.09
1972/73	ROE-SN	0.0	0.3	37.4	19.7	32.7	6.8	2.4	0.7	0.0	0.0	701	400	14.89
1973/74	ROE-SN	0.0	0.3	61.1	22.3	9.2	5.3	1.1	0.5	0.2	0.0	622	400	19.57
	ROE-GN	0.0	0.0	1.4	37.5	29.2	25.0	5.6	0.0	0.0	1.4	72	25	0.40
1974/75	ROE-SN	0.0	0.1	33.3	45.4	13.5	5.3	1.7	0.5	0.2	0.0	3026	400	37.00[b]
	ROE-GN	0.0	0.0	0.0	22.5	40.0	30.0	5.0	2.5	0.0	0.0	40	25	0.62
1975/76	ROE-SN	0.0	0.3	2.9	52.8	33.5	7.6	2.2	0.6	0.0	0.0	2629	400	69.03[c]
1976/77	ROE-SN	0.0	0.0	17.3	10.3	43.1	22.6	5.5	1.0	0.2	0.0	1825	400	68.88[bc]
1977/78	ROE-SN	0.0	0.1	24.7	17.1	11.1	33.0	12.2	1.7	0.0	0.0	784	400	66.17[c]
1978/79	ROE-SN	0.0	5.7	4.4	31.5	18.7	21.3	15.1	2.8	0.4	0.1	1021	400	39.21[b]
	ROE-GN	0.0	0.0	0.0	25.1	25.1	25.1	20.1	3.5	0.5	0.5	199	100	12.82
1979/80	ROE-SN	0.0	0.6	86.0	4.2	4.6	2.3	1.6	0.6	0.1	0.0	2390	400	14.49
	ROE-GN	0.0	0.0	4.4	4.0	40.5	20.5	24.5	5.0	1.1	0.0	755	100	6.01
1980/81	ROE-SN	0.0	0.2	3.0	85.3	5.4	3.2	2.0	0.7	0.2	0.1	4586	400	33.10[b]
	ROE-GN	0.0	0.0	0.2	74.8	8.3	9.4	4.9	1.9	0.6	0.0	905	100	12.14
1981/82	ROE-SN	0.0	0.6	3.9	3.6	87.1	2.0	1.3	0.9	0.4	0.1	3027	400	18.64[b]
	ROE-GN	0.0	0.0	0.2	3.4	88.2	3.4	2.7	1.1	0.8	0.2	526	100	9.92

Appendix Table 1.1. (cont'd)

SEASON	FISHERY	PERCENT AT AGE 1	2	3	4	5	6	7	8	9	10	NUMBER AGED	SAMPLE WEIGHT	CATCH ($\times 10^{-6}$)
1982/83	ROE-SN	0.0	4.0	4.7	3.6	6.5	75.2	3.6	1.5	0.8	0.2	1759	400	31.58[b]
	ROE-GN	0.0	0.0	0.0	1.3	2.8	89.0	3.1	2.5	0.7	0.5	747	100	5.89
1983/84	OTHER	0.0	5.9	36.6	2.2	4.3	8.6	39.2	2.2	0.5	0.5	186	25	0.93
	ROE-SN	0.0	1.9	35.8	4.8	2.7	10.4	42.9	1.1	0.4	0.2	3013	400	31.95
	ROE-GN	0.0	0.0	2.8	1.3	4.6	9.0	80.1	1.8	0.3	0.3	391	100	3.46
1984/85	ROE-SN	0.0	1.3	14.9	31.8	4.0	4.5	11.4	31.5	0.4	0.1	3556	400	31.16[b]
	ROE-GN	0.0	0.0	0.0	15.3	2.1	4.2	11.1	66.7	0.7	0.0	144	100	8.58
1985/86	ROE-SN	0.0	0.2	2.9	22.0	40.2	4.1	3.2	8.0	19.1	0.3	4638	400	16.82
	ROE-GN	0.0	0.0	0.0	11.9	50.6	5.4	5.2	10.4	16.0	0.5	405	100	4.93

	AVERAGE WEIGHT AT AGE (gms)									
FISHERY	1	2	3	4	5	6	7	8	9	10
REDUCTION	11.7	51.9	85.1	106.4	124.8	147.4	155.4	167.3	147.3	183.5
ROE-SN	0.0	66.7	98.6	127.1	151.7	174.2	190.5	203.5	212.8	211.6
ROE-GN	0.0	0.0	117.5	139.9	151.7	168.0	176.7	188.6	188.8	193.4

[a] - Age composition from published reports.
[b] - includes catch from "other" fisheries.
[c] - includes catch from gillnet fisheries.

Appendix Table 1.2. Age composition and catch in numbers by fishery and season and weight at age averaged over all seasons for the Prince Rupert District stock assessment region. Data are used for age-structured model analysis.

SEASON	FISHERY	PERCENT AT AGE 1	2	3	4	5	6	7	8	9	10	NUMBER AGED	SAMPLE WEIGHT	CATCH ($\times 10^{-6}$)
1950/51	REDUCTION	0.0	4.3	18.2	58.5	10.4	5.6	2.6	0.3	0.0	0.0	4684	400	495.47
1951/52	REDUCTION	0.1	4.8	8.8	33.7	45.2	6.1	1.0	0.3	0.0	0.0	5925	400	439.26
1952/53	REDUCTION	0.0	1.3	38.4	20.5	25.6	13.3	1.0	0.0	0.0	0.0	875	400	17.26
1953/54	REDUCTION	0.0	2.1	28.3	29.1	24.0	13.2	2.6	0.6	0.0	0.0	2657	400	252.24
1954/55	REDUCTION	0.0	2.7	4.9	70.3	15.6	5.2	1.1	0.2	0.0	0.0	1131	400	169.88
1955/56	REDUCTION	0.0	10.0	58.1	9.5	19.0	2.6	0.5	0.2	0.1	0.0	1683	400	121.81
1956/57	REDUCTION	0.0	11.5	17.8	39.8	13.2	16.0	1.4	0.3	0.0	0.0	3491	400	282.80
1957/58	REDUCTION	0.0	59.3	20.9	6.1	9.4	1.0	3.1	0.0	0.0	0.0	573	400	72.17
1958/59	REDUCTION	0.0	3.1	56.7	20.9	5.8	9.9	1.7	1.9	0.1	0.0	1741	400	103.71
1959/60	REDUCTION	0.0	49.1	6.3	28.2	8.9	4.1	2.5	0.7	0.2	0.0	4207	400	245.17
1960/61	REDUCTION	0.0	9.7	58.3	7.3	18.0	4.3	1.6	0.6	0.1	0.0	4300	400	481.55
1961/62	REDUCTION	0.0	3.0	30.3	44.7	6.9	9.9	3.4	0.9	0.5	0.3	1845	400	247.64
1962/63	REDUCTION	0.0	39.3	13.3	18.2	22.0	3.6	3.0	0.5	0.1	0.1	3415	400	478.87
1963/64	REDUCTION	0.0	3.7	65.0	10.1	10.9	8.9	0.7	0.6	0.1	0.0	3401	400	355.68
1964/65	REDUCTION	0.0	6.0	13.6	51.0	8.5	11.0	8.4	1.0	0.3	0.1	3362	400	364.67
1965/66	REDUCTION	0.0	0.0	5.3	21.4	23.4	16.3	19.1	9.7	3.2	1.6	435	400	107.20
1966/67	REDUCTION	1.7	45.7	31.2	6.2	5.2	5.6	2.6	1.5	0.4	0.0	0[a]	25	107.93
1967/68	REDUCTION	3.7	41.9	35.4	16.1	2.6	0.5	0.0	0.0	0.0	0.0	0[a]	25	31.29
1968/69	OTHER	1.1	16.3	48.4	26.0	7.2	0.8	0.2	0.0	0.0	0.0	0[a]	25	6.47
1969/70	OTHER	0.7	18.5	62.4	15.0	3.1	0.0	0.1	0.1	0.0	0.0	0[a]	25	19.15
1970/71	OTHER	0.0	10.4	49.7	27.3	7.3	4.0	0.8	0.5	0.2	0.0	656	400	43.37
1971/72	ROE-SN	0.0	0.0	5.3	17.9	64.4	5.9	3.8	2.4	0.1	0.1	714	400	27.87[bc]
1972/73	OTHER	0.0	22.9	47.7	7.8	13.1	4.6	2.6	1.3	0.0	0.0	153	25	3.57
	ROE-SN	0.0	0.3	33.1	4.4	30.3	26.6	3.4	1.3	0.8	0.0	798	400	9.43
1973/74	ROE-SN	0.0	0.2	17.9	53.2	7.4	16.5	4.4	0.3	0.2	0.0	632	400	17.44[b]
	ROE-GN	0.0	0.0	1.0	39.4	21.2	34.6	2.9	1.0	0.0	0.0	104	100	9.01
1974/75	OTHER	0.0	1.2	10.5	15.1	43.0	14.0	11.6	2.3	2.3	0.0	86	25	1.42
	ROE-SN	0.3	1.3	9.4	22.1	43.0	11.1	9.6	2.5	0.6	0.2	3084	400	11.66
	ROE-GN	0.0	0.0	0.0	31.9	59.6	8.5	0.0	0.0	0.0	0.0	47	25	0.10
1975/76	OTHER	0.0	0.0	4.9	6.8	9.9	16.7	17.9	35.2	8.6	0.0	162	25	3.10
	ROE-SN	0.0	0.0	0.8	6.9	31.7	50.1	7.3	2.4	0.8	0.0	713	400	20.40
	ROE-GN	0.0	0.0	0.0	15.8	57.9	22.8	3.5	0.0	0.0	0.0	57	25	1.79
1976/77	OTHER	0.0	0.4	23.3	15.7	22.9	16.7	10.8	7.5	2.4	0.4	510	25	6.15
	ROE-SN	0.0	0.1	16.0	3.7	22.7	37.8	15.0	3.3	0.9	0.5	1310	400	37.04
	ROE-GN	0.0	0.0	1.1	2.1	19.9	54.1	14.6	6.8	1.4	0.0	281	100	8.95
1977/78	OTHER	0.0	1.3	9.8	28.5	18.4	17.8	14.3	6.6	2.3	1.0	963	25	24.01
	ROE-SN	0.0	1.1	11.7	32.8	9.6	21.1	20.4	2.4	0.6	0.3	795	400	13.69
	ROE-GN	0.0	0.0	0.0	20.5	6.0	32.5	33.1	6.6	1.3	0.0	151	100	18.14
1978/79	OTHER	0.0	1.9	7.8	9.4	25.3	16.6	17.1	11.3	5.9	4.7	1076	25	11.76
	ROE-SN	0.0	2.7	18.2	11.5	29.2	11.5	18.2	6.5	1.4	0.8	959	400	8.44
	ROE-GN	0.0	1.1	1.1	8.0	41.4	15.7	22.2	8.0	1.9	0.4	261	100	7.40

Appendix Table 1.2. (cont'd)

SEASON	FISHERY	PERCENT AT AGE 1	2	3	4	5	6	7	8	9	10	NUMBER AGED	SAMPLE WEIGHT	CATCH ($\times 10^{-6}$)
1979/80	OTHER	0.0	1.1	61.2	6.6	7.9	8.1	6.6	4.9	2.1	1.6	1159	25	6.62
	ROE-SN	0.0	0.6	77.9	7.3	5.1	3.8	3.5	1.3	0.4	0.1	2811	400	17.17
	ROE-GN	0.0	0.0	3.4	8.7	31.2	22.3	21.1	9.1	3.4	0.6	493	100	6.37
1980/81	OTHER	0.0	1.0	7.4	54.6	9.3	10.2	9.3	4.3	2.3	1.5	6526	25	13.71
	ROE-SN	0.0	0.5	11.2	81.2	3.3	1.7	1.5	0.4	0.2	0.1	3238	400	10.60
	ROE-GN	0.0	0.0	0.5	38.9	15.5	23.0	14.8	5.6	1.9	0.0	427	100	2.38
1981/82	OTHER	0.0	1.5	11.5	20.5	41.1	10.5	6.6	5.0	2.1	1.1	2669	25	13.88
	ROE-SN	0.0	2.7	18.8	7.4	66.3	2.8	1.4	0.4	0.2	0.0	1544	400	1.65
1982/83	ROE-SN	0.0	1.2	20.6	17.8	5.3	49.3	3.8	1.2	0.6	0.2	4486	400	0.10[d]
1983/84	OTHER	0.0	2.8	36.2	15.7	13.9	9.8	16.4	2.8	1.1	1.4	654	25	1.80
	ROE-SN	0.0	0.5	35.5	14.4	10.3	14.4	23.6	1.0	0.2	0.1	2837	400	16.42
	ROE-GN	0.0	0.0	1.0	2.0	12.9	21.4	57.4	3.4	1.2	0.8	505	100	12.73
1984/85	OTHER	0.0	15.4	8.2	25.8	28.2	11.7	5.4	4.1	0.8	0.3	631	25	2.82
	ROE-SN	0.0	0.2	8.0	54.7	11.9	6.4	10.5	8.1	0.1	0.1	3758	400	27.86
	ROE-GN	0.0	0.0	0.4	16.4	14.9	15.8	21.8	29.8	0.4	0.5	550	100	23.50
1985/86	ROE-SN	0.0	1.8	13.8	9.4	46.3	10.8	5.3	7.1	5.5	0.1	5655	400	25.60
	ROE-GN	0.0	0.0	0.4	4.3	53.8	19.0	8.7	7.8	5.7	0.2	1274	100	33.36

FISHERY	AVERAGE WEIGHT AT AGE (gms) 1	2	3	4	5	6	7	8	9	10
REDUCTION	21.8	43.8	79.2	107.8	128.2	146.0	163.0	173.3	188.7	206.8
ROE-SN	8.6	53.0	85.1	116.7	141.8	161.1	175.6	190.2	200.0	211.5
ROE-GN	0.0	90.3	114.1	137.4	149.5	165.7	173.4	182.1	195.4	201.3

[a] - Age composition from published reports.
[b] - includes catch from "other" fisheries.
[c] - includes catch from gillnet fisheries.
[d] - No seine roe fishery in this season. Age composition from pre-fishery charter samples only.

Appendix Table 1.3. Age composition and catch in numbers by fishery and season and weight at age averaged over all seasons for the central coast stock assessment region. Data are used for age-structured model analysis.

SEASON	FISHERY	PERCENT AT AGE 1	2	3	4	5	6	7	8	9	10	NUMBER AGED	SAMPLE WEIGHT	CATCH (x10^{-6})
1950/51	REDUCTION	0.0	2.5	29.0	50.3	12.0	5.0	1.2	0.0	0.0	0.0	5229	400	390.00
1951/52	REDUCTION	1.3	2.7	19.8	31.5	38.2	4.6	1.5	0.5	0.0	0.0	4439	400	232.24
1952/53	REDUCTION	0.5	10.7	29.3	24.2	24.9	9.2	1.0	0.3	0.0	0.0	2559	400	7.55
1953/54	REDUCTION	0.0	1.7	70.6	21.4	4.7	1.3	0.1	0.0	0.1	0.0	2999	400	316.24
1954/55	REDUCTION	0.0	3.5	7.6	77.5	9.3	1.6	0.4	0.0	0.0	0.0	2707	400	134.31
1955/56	REDUCTION	0.0	10.7	12.5	9.9	63.2	3.2	0.4	0.0	0.0	0.0	4535	400	376.88
1956/57	REDUCTION	0.0	16.5	50.9	10.9	6.3	14.8	0.7	0.0	0.0	0.0	4778	400	274.01
1957/58	REDUCTION	0.0	23.2	61.3	13.0	1.3	0.6	0.6	0.0	0.0	0.0	3788	400	145.81
1958/59	REDUCTION	0.4	3.5	49.3	36.9	8.1	0.8	0.4	0.4	0.0	0.0	5046	400	337.17
1959/60	REDUCTION	0.0	45.2	21.4	27.3	5.2	0.8	0.1	0.1	0.0	0.0	931	400	48.14
1960/61	REDUCTION	0.0	16.8	31.5	10.7	30.0	9.8	1.0	0.1	0.1	0.0	2653	400	325.98
1961/62	REDUCTION	0.0	9.7	57.4	17.9	2.6	9.9	2.4	0.1	0.0	0.0	808	400	204.42
1962/63	REDUCTION	0.0	0.4	30.2	58.0	5.4	2.8	2.9	0.2	0.0	0.0	1088	400	460.74
1963/64	REDUCTION	0.0	10.5	47.3	29.8	11.0	1.3	0.1	0.0	0.0	0.0	1297	400	379.22
1964/65	REDUCTION	0.0	7.2	35.1	34.8	16.8	5.6	0.4	0.1	0.1	0.0	1654	400	128.36
1965/66	REDUCTION	9.7	54.0	19.1	9.0	4.8	1.7	1.1	0.4	0.0	0.1	0[a]	25	523.99
1966/67	REDUCTION	3.8	35.0	43.7	13.2	2.8	1.1	0.4	0.1	0.0	0.0	0[a]	25	302.59
1967/68	REDUCTION	2.2	37.3	43.1	15.3	2.0	0.1	0.0	0.0	0.0	0.0	0[a]	25	21.65
1968/69	OTHER	1.6	16.7	23.0	38.0	17.6	2.9	0.2	0.0	0.0	0.0	0[a]	25	1.07
1969/70	OTHER	39.5	32.7	26.9	0.7	0.2	0.0	0.0	0.0	0.0	0.0	0[a]	25	4.72
1970/71	OTHER	0.1	26.9	35.8	29.8	3.1	3.3	0.8	0.2	0.1	0.0	1278	400	38.00
1971/72	ROE-SN	0.0	4.4	29.8	27.6	25.7	7.0	4.4	1.1	0.1	0.0	1839	400	76.83[b]
	ROE-GN	0.0	0.0	0.9	14.9	65.0	10.6	7.9	0.6	0.0	0.0	329	100	0.85
1972/73	ROE-SN	0.0	1.2	50.5	18.6	15.5	11.7	1.9	0.5	0.2	0.0	1328	400	53.93[b]
	ROE-GN	0.0	0.0	2.5	25.3	44.9	20.9	4.4	1.3	0.6	0.0	158	100	7.13
1973/74	ROE-SN	0.1	2.8	17.7	38.6	19.7	13.4	6.6	0.9	0.3	0.0	1588	400	28.28[b]
	ROE-GN	0.0	0.0	0.4	22.8	37.7	24.8	12.3	1.8	0.2	0.0	496	100	33.25
1974/75	ROE-SN	0.3	1.1	32.9	25.3	27.7	8.6	3.2	0.7	0.1	0.0	9191	400	27.91
	ROE-GN	0.0	0.0	3.3	25.6	46.2	16.4	6.4	2.1	0.0	0.0	519	100	34.84
1975/76	ROE-SN	0.0	3.0	11.8	41.2	20.9	16.8	4.5	1.5	0.2	0.0	5418	400	49.45[b]
	ROE-GN	0.0	0.0	0.8	18.8	29.8	35.3	11.8	3.0	0.4	0.1	1222	100	38.27
1976/77	OTHER	0.0	1.0	32.8	18.7	29.8	8.1	6.6	3.0	0.0	0.0	198	25	3.27
	ROE-SN	0.0	0.7	17.4	22.7	31.7	16.6	8.5	1.9	0.4	0.0	2496	400	28.44
	ROE-GN	0.0	0.0	1.1	13.0	35.5	31.6	13.5	4.0	1.3	0.0	453	100	41.17
1977/78	ROE-SN	0.0	0.2	25.7	15.2	19.9	23.1	10.9	3.5	1.1	0.4	1399	400	35.39
	ROE-GN	0.0	0.0	1.3	8.9	29.5	38.1	17.7	3.9	0.5	0.1	1077	100	57.59
1979/80	ROE-SN	0.0	3.7	73.1	6.4	9.0	4.0	2.6	0.7	0.4	0.1	2580	400	0.11[b]
	ROE-GN	0.0	0.0	3.3	2.6	24.8	23.7	26.3	11.3	6.6	1.5	274	100	3.25
1980/81	ROE-SN	0.0	2.0	12.3	66.6	8.4	7.0	2.6	0.6	0.3	0.1	2952	400	2.57[b]
	ROE-GN	0.0	0.3	1.5	50.7	13.6	15.4	10.6	5.5	1.8	0.7	1536	100	16.30

Appendix Table 1.3 (cont'd)

SEASON	FISHERY	PERCENT AT AGE 1	2	3	4	5	6	7	8	9	10	NUMBER AGED	SAMPLE WEIGHT	CATCH ($\times 10^{-6}$)
1981/82	ROE-SN	0.0	1.7	15.6	10.7	60.2	5.2	4.6	1.5	0.5	0.1	3508	400	18.81[b]
	ROE-GN	0.0	0.0	2.4	5.9	76.0	6.7	5.9	2.3	0.7	0.1	1337	100	28.71
1982/83	ROE-SN	0.0	0.5	7.1	15.5	10.8	56.8	5.1	3.1	0.7	0.3	5392	400	15.49
	ROE-GN	0.0	0.0	0.5	7.2	13.1	69.4	5.0	3.9	0.6	0.3	1793	100	23.87
1983/84	ROE-SN	0.0	4.4	7.3	10.1	18.2	16.1	40.7	2.3	0.8	0.1	6295	400	28.42[b]
	ROE-GN	0.0	0.0	0.3	2.9	13.1	17.3	60.1	4.7	1.1	0.5	1159	100	24.23
1984/85	ROE-SN	0.0	2.7	37.5	7.5	8.6	13.1	11.9	18.2	0.4	0.1	5157	400	22.21
	ROE-GN	0.0	0.0	3.2	5.4	9.4	19.5	22.5	38.2	1.0	0.8	1288	100	14.35
1985/86	ROE-SN	0.0	3.9	16.4	40.3	8.6	6.3	6.7	6.1	11.3	0.5	5818	400	12.66
	ROE-GN	0.0	0.0	1.8	23.9	12.0	10.0	16.0	13.2	22.3	0.8	1069	100	6.81

FISHERY	AVERAGE WEIGHT AT AGE (gms) 1	2	3	4	5	6	7	8	9	10
REDUCTION	17.6	44.7	80.8	104.9	125.8	138.0	150.9	156.4	159.4	170.8
ROE-SN	70.1	54.0	89.0	114.9	135.9	153.6	168.7	183.5	196.7	207.1
ROE-GN	0.0	39.3	111.8	137.1	149.6	161.9	171.8	183.0	190.8	187.4

[a] - Age composition from published reports.
[b] - Includes catch from "other" fisheries.

Appendix Table 1.4. Age composition and catch in numbers by fishery and season and weight at age averaged over all seasons for the northern Strait of Georgia stock assessment region. Data are used for age-structured model analysis.

SEASON	FISHERY	PERCENT AT AGE 1	2	3	4	5	6	7	8	9	10	NUMBER AGED	SAMPLE WEIGHT	CATCH ($\times 10^{-6}$)
1950/51	REDUCTION	0.1	3.6	45.1	38.8	9.5	2.1	0.6	0.2	0.0	0.0	3471	400	173.41
1951/52	REDUCTION	0.1	11.7	52.3	27.5	6.8	1.4	0.2	0.0	0.0	0.0	5111	400	213.14
1952/53	REDUCTION	0.4	11.2	54.4	28.8	4.0	1.0	0.1	0.1	0.0	0.0	5952	400	98.18
1953/54	REDUCTION	0.0	2.3	34.0	39.2	16.7	5.7	1.7	0.4	0.0	0.0	6856	400	192.19
1954/55	REDUCTION	0.0	5.6	41.3	43.7	7.6	1.6	0.1	0.0	0.0	0.0	2551	400	282.79
1955/56	REDUCTION	0.0	9.5	16.4	28.1	36.9	7.4	1.2	0.4	0.1	0.0	4921	400	257.99
1956/57	REDUCTION	0.0	0.9	36.8	25.1	24.3	11.5	1.3	0.1	0.0	0.0	2420	400	186.75
1957/58	REDUCTION	0.0	6.4	44.3	23.4	9.5	9.6	5.8	0.8	0.1	0.0	3473	400	90.20
1958/59	REDUCTION	0.7	16.4	62.8	16.5	2.6	0.4	0.3	0.1	0.0	0.0	4731	400	437.22
1959/60	REDUCTION	0.0	11.3	40.9	40.3	6.1	0.9	0.3	0.1	0.0	0.1	1055	400	230.72
1960/61	REDUCTION	0.0	20.5	24.0	30.0	21.7	3.3	0.4	0.0	0.0	0.0	1179	400	146.23
1961/62	REDUCTION	0.0	13.3	63.4	12.7	7.2	2.8	0.6	0.0	0.0	0.0	1506	400	344.76
1962/63	REDUCTION	0.0	20.5	48.0	25.2	3.3	1.8	1.0	0.2	0.0	0.0	1151	400	416.00
1963/64	REDUCTION	0.0	5.7	64.9	26.5	2.2	0.6	0.1	0.0	0.0	0.0	2316	400	366.30
1964/65	REDUCTION	0.2	13.9	53.5	28.2	2.7	1.1	0.3	0.1	0.0	0.0	2071	400	258.80
1965/66	REDUCTION	0.0	14.7	36.9	24.6	18.2	3.7	1.9	0.0	0.0	0.0	374	100	164.68
1966/67	REDUCTION	7.4	30.4	46.7	10.2	3.1	1.9	0.3	0.0	0.0	0.0	0[a]	25	151.58
1967/68	REDUCTION	25.5	22.4	40.7	9.2	1.7	0.3	0.2	0.1	0.0	0.0	0[a]	25	15.35
1968/69	OTHER	25.3	48.2	24.8	1.6	0.1	0.0	0.0	0.0	0.0	0.0	0[a]	25	6.40
1969/70	OTHER	0.6	23.6	62.9	11.1	1.4	0.5	0.0	0.0	0.0	0.0	0[a]	25	6.58
1970/71	OTHER	6.1	20.2	36.6	28.9	5.5	2.5	0.2	0.0	0.0	0.0	1206	400	9.27
1971/72	OTHER	0.0	2.4	28.8	36.0	25.4	5.0	2.1	0.3	0.0	0.0	1136	25	5.67
	ROE-SN	0.0	4.2	39.2	31.5	19.6	4.3	1.1	0.0	0.0	0.0	2571	400	46.94
	ROE-GN	0.0	1.1	12.5	50.2	28.0	6.5	1.1	0.4	0.4	0.0	279	100	0.10
1972/73	OTHER	0.1	0.5	23.5	33.0	26.8	13.9	1.9	0.3	0.0	0.0	3914	25	26.49
	ROE-SN	0.0	4.2	54.9	21.4	12.9	6.1	0.5	0.0	0.0	0.0	379	100	13.70
	ROE-GN	0.0	0.0	5.5	27.3	52.7	10.9	3.6	0.0	0.0	0.0	55	25	8.72
1973/74	ROE-GN	0.0	0.0	3.6	43.1	33.1	17.1	2.9	0.3	0.0	0.0	662	100	20.39[be]
1974/75	OTHER	1.1	22.1	60.4	12.3	2.1	1.4	0.5	0.0	0.2	0.0	439	25	6.56
	ROE-SN	1.7	3.5	57.3	27.0	7.1	2.6	0.5	0.2	0.1	0.0	3091	400	5.02
	ROE-GN	0.0	0.0	6.7	31.9	43.7	13.4	3.4	0.8	0.0	0.0	119	100	28.34
1975/76	OTHER	0.1	7.9	17.6	34.9	25.5	8.6	3.7	1.3	0.2	0.1	1380	25	15.05
	ROE-SN	0.0	13.3	26.3	43.3	14.1	2.2	0.3	0.4	0.0	0.0	729	400	2.09
	ROE-GN	0.0	0.0	0.5	39.1	44.0	12.9	3.0	0.4	0.1	0.0	737	100	40.52
1976/77	OTHER	0.0	3.2	19.7	24.8	36.9	14.6	0.6	0.0	0.0	0.0	157	25	4.63
	ROE-SN	0.1	3.3	57.8	20.8	14.4	3.0	0.4	0.2	0.0	0.0	2234	400	37.07
	ROE-GN	0.0	0.0	3.2	26.1	48.7	17.2	4.1	0.6	0.1	0.0	1423	100	46.61
1977/78	OTHER	0.1	4.7	38.0	28.4	9.6	11.6	5.7	1.2	0.5	0.1	758	25	35.75
	ROE-SN	0.0	0.8	34.9	42.8	11.9	7.7	1.5	0.3	0.0	0.1	3146	400	35.35
	ROE-GN	0.0	0.0	0.4	19.7	31.5	35.1	11.1	1.7	0.4	0.0	461	100	42.70

Appendix Table 1.4 (cont'd)

SEASON	FISHERY	PERCENT AT AGE 1	2	3	4	5	6	7	8	9	10	NUMBER AGED	SAMPLE WEIGHT	CATCH ($\times 10^{-6}$)
1978/79	OTHER	0.0	1.2	15.2	35.5	26.3	11.2	8.4	1.7	0.5	0.2	598	25	16.03
	ROE-SN	0.0	1.0	17.7	31.0	32.5	10.2	5.8	1.5	0.2	0.0	889	400	0.10[d]
	ROE-GN	0.0	0.0	1.2	23.2	54.7	13.5	5.8	1.5	0.0	0.2	607	100	44.18
1979/80	OTHER	1.9	4.5	41.0	21.8	17.0	8.2	3.1	1.8	0.5	0.1	1508	25	11.32
	ROE-SN	0.0	2.4	48.5	16.2	18.1	10.5	2.6	1.3	0.3	0.1	3455	400	1.69
	ROE-GN	0.0	0.0	2.1	9.2	44.8	33.2	8.4	2.0	0.3	0.0	705	100	21.56
1980/81	OTHER	0.0	1.8	40.6	36.5	13.3	4.7	2.1	0.5	0.5	0.0	655	25	2.30
	ROE-SN	0.0	6.9	37.0	30.1	11.4	9.6	3.9	0.6	0.3	0.0	6893	400	20.15
	ROE-GN	0.0	0.1	2.2	18.2	23.0	37.4	16.1	2.8	0.3	0.1	1140	100	33.31
1981/82	OTHER	0.0	0.0	25.8	35.2	28.3	4.4	2.5	2.5	0.0	1.3	159	25	1.00
	ROE-SN	0.0	6.9	31.4	24.8	21.1	5.6	6.3	3.0	0.9	0.1	2244	400	0.10[d]
	ROE-GN	0.0	0.0	4.4	15.4	28.5	14.8	20.8	14.2	1.7	0.4	833	100	36.74
1982/83	OTHER	0.0	27.2	47.2	13.9	7.8	2.8	0.0	1.1	0.0	0.0	180	25	1.06
	ROE-SN	0.0	2.4	31.6	28.6	17.7	12.0	3.3	2.9	1.2	0.2	9844	400	67.56
	ROE-GN	0.0	0.0	0.5	27.8	29.5	23.6	9.3	7.4	1.7	0.2	407	100	56.38
1983/84	OTHER	0.0	8.7	39.4	28.5	11.0	7.3	3.7	1.4	0.0	0.0	355	25	1.90
	ROE-SN	0.0	4.7	39.3	31.4	12.8	6.6	3.5	1.0	0.5	0.1	5747	400	35.15
	ROE-GN	0.0	0.0	7.0	30.2	31.1	19.2	9.3	1.7	0.7	0.9	766	100	42.15
1984/85	OTHER	0.0	13.1	50.8	20.3	10.2	4.0	1.3	0.3	0.0	0.0	679	25	1.02
	ROE-SN	0.0	22.0	45.5	19.4	8.4	3.0	1.2	0.4	0.1	0.0	5846	400	28.81
	ROE-GN	0.0	0.1	3.1	26.1	32.5	23.6	9.2	3.7	0.8	0.8	1096	100	23.72
1985/86	ROE-SN	0.1	10.5	54.9	24.5	6.8	2.1	0.8	0.2	0.0	0.0	4457	400	0.10[d]

	AVERAGE WEIGHT AT AGE (gms)									
FISHERY	1	2	3	4	5	6	7	8	9	10
REDUCTION	14.9	46.5	84.3	110.9	133.3	149.9	169.2	174.5	194.0	188.3
ROE-SN	17.0	56.0	82.5	111.7	133.3	152.6	170.0	180.2	177.4	189.1
ROE-GN	0.0	67.2	118.5	137.5	150.2	162.7	171.4	184.9	182.4	184.7

[a] - Age composition from published reports.
[b] - Includes catch from "other" fisheries.
[d] - No seine roe fishery in this season. Age composition from pre-fishery charter samples only.
[e] - Includes catch from seine roe fisheries.

Appendix Table 1.5. Age composition and catch in numbers by fishery and season and weight at age averaged over all seasons for the southern Strait of Georgia stock assessment region. Data are used for age-structured model analysis.

SEASON	FISHERY	PERCENT AT AGE 1	2	3	4	5	6	7	8	9	10	NUMBER AGED	SAMPLE WEIGHT	CATCH ($\times 10^{-6}$)
1950/51	REDUCTION	0.0	4.7	65.6	23.5	5.1	0.9	0.1	0.0	0.0	0.0	4262	400	268.83
1951/52	REDUCTION	0.1	10.5	59.2	21.8	6.7	1.2	0.4	0.1	0.0	0.0	3921	400	271.05
1952/53	REDUCTION	0.0	4.0	65.5	26.7	3.1	0.6	0.0	0.0	0.0	0.0	1759	400	7.24
1953/54	REDUCTION	0.0	0.7	58.4	34.2	5.9	0.6	0.1	0.0	0.0	0.0	6306	400	465.15
1954/55	REDUCTION	0.0	3.3	56.4	33.8	5.7	0.6	0.1	0.0	0.0	0.0	2634	400	410.84
1955/56	REDUCTION	0.0	4.5	53.8	29.5	10.4	1.5	0.2	0.0	0.0	0.0	4913	400	473.48
1956/57	REDUCTION	0.0	1.6	70.8	21.0	4.2	2.0	0.3	0.1	0.0	0.0	5059	400	412.23
1957/58	REDUCTION	0.0	10.3	64.1	21.3	3.0	1.0	0.3	0.1	0.0	0.0	3829	400	135.41
1958/59	REDUCTION	0.8	17.5	63.9	14.4	2.5	0.6	0.2	0.1	0.0	0.0	5309	400	175.62
1959/60	REDUCTION	0.0	4.5	57.2	35.2	2.5	0.4	0.1	0.1	0.0	0.0	2490	400	447.54
1960/61	REDUCTION	0.0	36.3	29.5	25.3	8.1	0.8	0.0	0.0	0.0	0.0	3001	400	349.21
1961/62	REDUCTION	0.0	5.2	76.0	13.6	3.6	1.4	0.2	0.1	0.0	0.0	1697	400	368.78
1962/63	REDUCTION	0.0	14.2	53.5	29.3	2.7	0.2	0.1	0.0	0.0	0.0	1108	400	388.49
1963/64	REDUCTION	0.1	6.3	55.6	34.4	3.0	0.5	0.1	0.1	0.0	0.0	1712	400	379.42
1964/65	REDUCTION	0.0	16.2	58.1	22.6	2.3	0.7	0.0	0.2	0.0	0.0	1259	400	196.58
1965/66	REDUCTION	0.0	31.0	32.7	23.8	11.1	1.0	0.5	0.0	0.0	0.0	416	400	132.76
1966/67	REDUCTION	17.0	33.7	35.9	11.2	1.9	0.3	0.0	0.0	0.0	0.0	0[a]	25	276.48
1967/68	REDUCTION	50.9	24.4	14.3	6.9	2.2	1.2	0.0	0.0	0.0	0.0	0[a]	25	20.14
1968/69	OTHER	27.1	37.2	22.8	9.7	2.6	0.6	0.0	0.0	0.0	0.0	0[a]	25	6.66
1969/70	OTHER	0.4	27.4	57.2	7.8	5.1	1.0	1.1	0.0	0.0	0.0	0[a]	25	4.09
1970/71	OTHER	3.3	17.6	33.1	34.7	7.1	2.2	1.8	0.2	0.0	0.0	450	400	7.05
1971/72	OTHER	0.0	13.9	33.2	34.0	14.9	2.8	1.0	0.1	0.0	0.0	2526	25	15.46
	ROE-SN	0.0	14.0	28.6	36.0	17.4	2.8	1.0	0.2	0.0	0.0	2262	400	3.85
	ROE-GN	0.0	5.7	11.1	45.2	29.3	7.0	1.6	0.1	0.0	0.0	757	100	0.96
1972/73	OTHER	0.0	3.4	49.6	21.2	18.6	5.5	1.1	0.5	0.1	0.0	797	25	2.71
	ROE-GN	0.0	0.0	21.3	31.4	32.5	11.2	3.0	0.6	0.0	0.0	169	100	4.36
1973/74	OTHER	0.0	17.4	73.3	8.1	1.2	0.0	0.0	0.0	0.0	0.0	86	25	3.90
	ROE-GN	0.0	0.0	7.3	40.4	27.7	16.1	6.4	2.1	0.0	0.0	329	100	3.02
1974/75	ROE-SN	0.0	3.9	50.1	28.7	8.7	4.3	3.1	0.9	0.3	0.0	2155	400	0.25[b]
	ROE-GN	0.0	0.0	1.6	64.5	21.0	9.7	3.2	0.0	0.0	0.0	62	25	6.82
1975/76	OTHER	0.0	5.5	21.7	44.3	19.7	5.2	2.3	0.8	0.5	0.0	3023	25	24.99
	ROE-SN	0.0	9.6	22.1	35.5	16.0	5.6	6.1	3.6	1.3	0.3	394	100	0.10[d]
	ROE-GN	0.0	0.0	0.7	41.5	41.5	11.6	2.7	2.0	0.0	0.0	147	100	6.38
1976/77	OTHER	0.0	1.8	52.7	23.2	16.8	4.0	1.0	0.3	0.1	0.1	2040	25	46.21
	ROE-SN	2.7	12.4	44.5	13.6	9.7	6.2	5.4	3.4	1.3	0.7	595	400	3.35
	ROE-GN	0.0	0.0	4.6	48.6	35.4	10.3	1.1	0.0	0.0	0.0	175	100	4.81
1977/78	OTHER	0.0	1.2	35.1	45.8	10.7	5.6	1.3	0.1	0.2	0.1	1711	25	81.96
	ROE-SN	0.0	1.1	40.4	46.4	7.5	4.3	0.4	0.0	0.0	0.0	280	100	0.10[d]
	ROE-GN	0.0	0.0	1.9	23.1	24.0	38.5	12.5	0.0	0.0	0.0	104	100	5.78

Appendix Table 1.5 (cont'd)

SEASON	FISHERY	PERCENT AT AGE 1	2	3	4	5	6	7	8	9	10	NUMBER AGED	SAMPLE WEIGHT	CATCH ($\times 10^{-6}$)
1978/79	OTHER	0.0	1.9	18.3	37.9	29.2	8.0	3.4	1.0	0.3	0.1	4551	25	92.12
	ROE-SN	0.0	2.3	24.6	35.3	21.6	7.5	3.8	2.7	1.2	1.0	601	400	0.10[d]
1979/80	OTHER	0.0	1.4	45.3	24.0	17.7	8.4	1.7	1.1	0.3	0.1	2836	25	10.92
	ROE-SN	0.0	3.0	57.9	12.0	15.9	6.8	2.9	0.8	0.2	0.5	591	400	0.10[d]
1980/81	OTHER	0.0	3.9	33.3	33.9	15.9	9.1	3.2	0.5	0.1	0.0	4505	25	39.06
	ROE-SN	0.0	8.6	38.4	29.9	10.6	8.8	2.8	0.6	0.2	0.0	648	400	0.10[d]
1981/82	OTHER	0.0	3.5	38.0	31.9	15.7	5.9	4.1	0.9	0.1	0.0	2234	25	30.30
	ROE-SN	0.0	8.7	39.7	23.1	17.4	3.8	4.5	2.2	0.5	0.0	2096	400	30.26
1982/83	OTHER	0.0	0.8	16.6	32.0	23.2	13.2	4.9	5.7	3.0	0.6	1910	25	4.73
	ROE-SN	0.0	5.9	29.6	27.9	18.5	9.1	2.9	3.9	1.7	0.5	2029	400	2.24
1983/84	OTHER	0.0	16.2	30.0	21.9	18.5	8.3	3.3	0.9	0.5	0.4	1527	25	5.25
	ROE-SN	0.0	21.9	31.4	18.8	13.4	9.3	2.6	1.5	0.6	0.3	1406	400	4.41
1984/85	OTHER	0.0	33.4	37.1	18.7	6.7	2.8	0.9	0.4	0.1	0.0	1843	25	6.45
	ROE-SN	0.0	30.0	38.2	18.0	6.5	4.6	1.7	1.0	0.1	0.1	1978	400	1.21
1985/86	ROE-SN	0.0	19.3	58.4	15.1	4.6	1.6	0.8	0.1	0.1	0.0	1609	400	0.10[d]

	AVERAGE WEIGHT AT AGE (gms)									
FISHERY	1	2	3	4	5	6	7	8	9	10
REDUCTION	15.7	57.7	93.1	118.2	142.5	159.8	175.9	187.9	193.0	224.6
ROE-SN	10.1	58.6	86.7	113.1	136.7	162.7	172.7	192.0	202.0	211.1
ROE-GN	0.0	59.4	110.4	140.1	155.4	168.6	180.5	176.4	0.0	0.0

[a] - Age composition from published reports.
[b] - Includes catch from "other" fisheries.
[d] - No seine roe fishery in this season. Age composition from pre-fishery charter samples only.

Appendix Table 1.6. Age composition and catch in numbers by fishery and season and weight at age averaged over all seasons for the southern west coast of Vancouver Island stock assessment region. Data are used for age-structured model analysis.

SEASON	FISHERY	PERCENT AT AGE 1	2	3	4	5	6	7	8	9	10	NUMBER AGED	SAMPLE WEIGHT	CATCH ($\times 10^{-6}$)
1950/51	REDUCTION	0.1	13.1	38.1	40.6	6.4	1.3	0.3	0.0	0.0	0.0	3843	400	163.06
1951/52	REDUCTION	0.1	5.3	65.5	20.1	7.9	0.8	0.2	0.0	0.0	0.0	1686	400	110.56
1952/53	REDUCTION	0.1	8.9	55.7	32.8	2.0	0.5	0.0	0.0	0.0	0.0	2777	400	0.24
1953/54	REDUCTION	0.1	2.4	64.0	26.9	6.0	0.5	0.1	0.0	0.0	0.0	3798	400	307.78
1954/55	REDUCTION	0.1	14.8	55.5	24.0	4.3	1.3	0.1	0.0	0.0	0.0	797	400	68.74
1955/56	REDUCTION	0.0	12.1	67.2	15.8	4.3	0.4	0.0	0.0	0.0	0.0	2209	400	195.32
1956/57	REDUCTION	0.0	1.4	76.4	21.1	1.0	0.2	0.0	0.0	0.0	0.0	0[a]	25	27.50
1957/58	REDUCTION	0.0	15.6	55.3	25.0	4.0	0.1	0.0	0.0	0.0	0.0	707	400	6.86
1958/59	REDUCTION	0.0	6.4	61.0	25.1	6.0	1.0	0.1	0.2	0.1	0.0	2066	400	431.57
1959/60	REDUCTION	0.0	26.9	48.2	19.7	4.1	0.6	0.4	0.2	0.0	0.0	539	400	198.88
1960/61	REDUCTION	0.0	52.7	33.9	10.0	3.1	0.2	0.0	0.0	0.0	0.0	419	400	171.97
1961/62	REDUCTION	0.0	5.1	78.2	12.1	3.7	0.9	0.0	0.0	0.0	0.0	751	400	165.95
1962/63	REDUCTION	0.0	3.5	44.4	45.5	5.6	0.8	0.2	0.0	0.0	0.0	886	400	40.43
1963/64	REDUCTION	0.0	2.6	60.8	25.5	10.1	0.8	0.3	0.0	0.0	0.0	1134	400	198.98
1964/65	REDUCTION	0.0	2.3	34.7	49.3	9.8	3.5	0.4	0.0	0.0	0.0	775	400	114.19
1965/66	REDUCTION	0.0	0.3	41.3	33.3	21.3	2.7	1.0	0.0	0.0	0.0	300	100	63.62
1966/67	REDUCTION	6.3	32.0	45.5	11.8	2.8	0.7	0.5	0.3	0.0	0.0	0[a]	25	115.39
1971/72	ROE-SN	0.0	4.1	19.9	50.8	20.0	3.3	1.1	0.8	0.0	0.0	1222	400	31.95
1972/73	ROE-SN	0.0	0.9	32.3	24.1	31.0	10.1	1.3	0.3	0.1	0.0	1967	400	67.82
	ROE-GN	0.0	0.0	7.9	22.9	51.8	13.5	2.9	1.0	0.2	0.0	624	100	6.38
1973/74	ROE-SN	0.0	12.1	45.1	25.7	11.0	5.0	1.0	0.1	0.0	0.0	3022	400	34.19
	ROE-GN	0.0	0.0	26.1	30.7	26.1	13.6	3.4	0.0	0.0	0.0	176	100	20.77
1974/75	ROE-SN	0.0	0.7	46.5	21.9	14.2	9.4	5.7	1.4	0.2	0.0	6192	400	90.12[b]
	ROE-GN	0.0	0.0	3.0	30.5	37.9	21.2	7.1	0.4	0.0	0.0	269	100	40.80
1975/76	ROE-SN	0.0	0.1	7.6	45.5	20.8	14.4	8.3	2.8	0.5	0.0	7026	400	135.88
	ROE-GN	0.0	0.0	0.7	41.7	33.6	15.4	5.9	2.3	0.3	0.1	1239	100	93.22
1976/77	ROE-SN	0.0	0.5	11.8	32.1	37.5	12.5	4.1	1.5	0.2	0.0	6171	400	122.66[b]
	ROE-GN	0.0	1.0	6.1	23.0	45.4	16.8	6.1	1.5	0.0	0.0	196	100	66.72
1977/78	OTHER	0.0	1.3	41.9	26.2	13.7	13.5	2.0	0.9	0.3	0.3	1727	25	18.33
	ROE-SN	0.0	0.5	35.1	18.7	18.6	20.8	4.8	1.3	0.2	0.1	5068	400	38.12
	ROE-GN	0.0	0.0	1.2	5.3	20.1	49.6	17.3	5.8	0.5	0.2	417	100	73.09
1978/79	ROE-SN	0.0	0.5	9.9	39.2	18.5	16.4	11.9	2.6	0.8	0.2	2165	400	41.19[b]
	ROE-GN	0.0	0.0	1.1	23.9	27.8	27.1	17.7	2.1	0.2	0.0	468	100	26.30
1979/80	ROE-SN	0.0	3.5	45.1	11.3	18.2	9.2	8.4	3.4	0.7	0.1	2028	400	14.67[b]
	ROE-GN	0.0	0.0	0.0	4.4	40.7	25.6	16.8	11.4	0.8	0.3	386	100	3.66
1980/81	ROE-SN	0.0	4.0	37.7	26.4	10.6	11.5	6.4	2.8	0.6	0.0	3162	400	25.11[b]
	ROE-GN	0.0	0.0	1.8	21.0	14.9	36.3	18.9	7.1	0.0	0.0	281	100	13.63
1981/82	ROE-SN	0.0	4.0	24.8	28.6	23.5	5.3	8.5	3.1	1.7	0.4	3931	400	20.11[b]
	ROE-GN	0.0	0.0	0.3	17.3	39.5	11.4	23.3	5.4	2.6	0.3	352	100	4.95

Appendix Table 1.6 (cont'd)

SEASON	FISHERY	PERCENT AT AGE 1	2	3	4	5	6	7	8	9	10	NUMBER AGED	SAMPLE WEIGHT	CATCH ($\times 10^{-6}$)
1982/83	ROE-SN	0.0	4.5	23.3	22.8	21.7	16.2	4.0	5.3	1.2	1.1	2761	400	47.64
1983/84	ROE-SN	0.0	20.5	36.8	14.1	9.6	10.5	6.1	1.1	1.1	0.2	2903	400	48.54
1984/85	ROE-SN	0.0	21.1	50.2	16.1	4.1	2.9	3.4	1.8	0.1	0.3	2342	400	1.60[b]
1985/86	ROE-SN	0.0	4.2	48.8	27.2	10.3	3.9	2.7	2.1	0.7	0.1	3127	400	0.10[d]

	AVERAGE WEIGHT AT AGE (gms)									
FISHERY	1	2	3	4	5	6	7	8	9	10
REDUCTION	20.6	56.1	89.6	112.8	132.1	149.3	156.4	166.8	173.2	237.6
ROE-SN	21.0	63.2	92.8	123.2	148.5	169.4	183.0	193.6	204.0	205.7
ROE-GN	0.0	95.5	104.3	135.4	154.0	168.4	179.3	184.6	192.9	188.5

[a] - Age composition from published reports.
[b] - Includes catch from "other" fisheries.
[d] - No seine roe fishery in this season. Age composition from pre-fishery charter samples only.

Appendix Table 1.7. Age composition and catch in numbers by fishery and season and weight at age averaged over all seasons for the northern west coast of Vancouver Island stock assessment region. Data are used for age-structured model analysis.

SEASON	FISHERY	PERCENT AT AGE 1	2	3	4	5	6	7	8	9	10	NUMBER AGED	SAMPLE WEIGHT	CATCH ($\times 10^{-6}$)
1950/51	REDUCTION	0.0	1.5	27.0	54.1	12.8	3.6	1.0	0.0	0.0	0.0	196	100	56.61
1951/52	REDUCTION	0.0	0.3	10.5	28.1	51.4	7.0	2.0	0.6	0.1	0.0	2430	400	126.98
1953/54	REDUCTION	0.0	0.0	37.5	51.2	8.9	2.1	0.3	0.0	0.0	0.0	381	100	94.40
1954/55	REDUCTION	0.0	9.4	33.5	48.1	6.7	1.8	0.3	0.1	0.0	0.0	981	400	63.65
1955/56	REDUCTION	0.0	4.6	50.9	22.5	18.6	3.5	0.0	0.0	0.0	0.0	0[a]	25	4.95
1956/57	REDUCTION	0.0	0.0	51.5	28.9	15.5	4.1	0.0	0.0	0.0	0.0	97	25	4.85
1957/58	REDUCTION	0.0	21.9	34.9	22.9	8.3	5.7	4.2	1.6	0.5	0.0	192	100	0.53
1958/59	REDUCTION	0.1	1.5	24.5	30.2	25.0	7.6	5.3	4.4	1.2	0.3	1509	400	319.30
1959/60	REDUCTION	0.0	5.0	56.8	23.8	9.6	3.2	1.0	0.4	0.2	0.1	2435	400	394.12
1960/61	REDUCTION	0.0	19.3	42.4	31.9	6.1	0.3	0.0	0.0	0.0	0.0	295	100	184.05
1961/62	REDUCTION	0.0	7.1	78.7	9.4	3.1	1.1	0.6	0.0	0.0	0.0	1090	400	136.30
1962/63	REDUCTION	0.0	0.5	47.3	47.4	3.7	0.9	0.1	0.0	0.0	0.0	1718	400	165.82
1963/64	REDUCTION	0.0	1.0	53.8	28.2	15.9	1.0	0.0	0.0	0.0	0.0	195	100	18.29
1964/65	REDUCTION	0.0	0.9	22.2	43.6	26.5	4.7	0.4	0.9	0.9	0.0	234	100	35.26
1965/66	REDUCTION	0.0	7.0	25.4	29.0	26.2	10.7	1.7	0.0	0.0	0.0	0[a]	25	37.67
1966/67	REDUCTION	0.3	6.1	63.3	23.1	5.7	1.3	0.1	0.1	0.0	0.0	0[a]	25	65.46
1971/72	ROE-SN	0.0	0.3	13.8	38.7	40.7	4.3	1.4	0.6	0.3	0.0	349	100	17.78
1972/73	ROE-SN	0.0	0.2	24.5	24.8	35.0	13.0	2.3	0.2	0.2	0.0	609	400	55.74[c]
1973/74	ROE-SN	0.0	3.0	40.4	21.7	17.0	13.8	3.7	0.4	0.1	0.0	2399	400	86.26[c]
1974/75	ROE-SN	0.0	0.5	66.3	16.3	6.6	5.4	3.7	1.1	0.1	0.0	4187	400	68.56[bc]
1975/76	ROE-SN	0.0	0.5	12.8	51.5	16.7	8.2	7.5	2.5	0.3	0.0	2204	400	25.91
	ROE-GN	0.0	0.0	2.7	33.8	30.4	18.6	9.9	4.6	0.0	0.0	263	100	13.90
1976/77	ROE-SN	0.0	1.7	21.2	21.8	42.5	7.3	2.8	2.2	0.6	0.0	179	100	5.68
	ROE-GN	0.0	0.0	0.0	8.6	39.5	18.5	19.8	9.9	3.1	0.6	162	100	18.00
1977/78	OTHER	0.0	1.3	49.6	15.0	14.4	16.4	2.6	0.6	0.3	0.0	702	25	8.19
	ROE-SN	0.0	1.7	69.0	13.3	6.4	5.8	2.2	1.5	0.1	0.1	896	400	7.84
	ROE-GN	0.0	0.0	1.1	2.7	21.8	41.0	23.4	8.5	1.1	0.5	188	100	20.92
1978/79	ROE-SN	0.0	1.2	18.1	65.2	9.1	3.3	2.7	0.3	0.1	0.1	1801	400	49.51
	ROE-GN	0.0	0.0	2.0	43.5	18.4	17.7	17.7	0.7	0.0	0.0	147	100	29.91
1979/80	ROE-SN	0.0	1.6	41.5	22.5	30.1	3.2	1.0	0.1	0.0	0.0	966	400	0.10[d]
	ROE-GN	0.0	0.0	2.1	9.9	77.3	8.5	1.4	0.7	0.0	0.0	141	100	15.98
1980/81	ROE-SN	0.0	1.3	15.2	54.5	10.5	16.5	1.9	0.1	0.0	0.0	1346	400	18.53
	ROE-GN	0.0	0.0	0.0	98.1	1.9	0.0	0.0	0.0	0.0	0.0	53	25	15.47
1981/82	ROE-SN	0.0	0.5	27.8	17.5	38.2	5.0	9.9	0.9	0.2	0.0	2171	400	2.13
	ROE-GN	0.0	0.0	0.8	7.9	47.6	11.5	29.0	3.1	0.2	0.0	620	100	19.78
1982/83	ROE-SN	0.0	3.9	20.1	18.4	18.1	29.4	5.0	5.0	0.2	0.0	642	400	0.10[d]
	ROE-GN	0.0	0.0	0.3	13.5	22.7	47.0	6.0	10.0	0.3	0.2	651	100	18.82
1983/84	ROE-SN	0.0	42.0	44.9	4.5	1.1	2.3	3.4	0.6	1.1	0.0	176	100	0.10
	ROE-GN	0.0	0.0	1.0	5.6	28.1	25.9	32.5	4.2	2.4	0.2	1027	100	6.65

Appendix Table 1.7 (cont'd)

SEASON	FISHERY	PERCENT AT AGE 1	2	3	4	5	6	7	8	9	10	NUMBER AGED	SAMPLE WEIGHT	CATCH ($\times 10^{-6}$)
1984/85	ROE-SN	0.0	18.2	65.7	7.5	2.4	2.3	2.4	1.2	0.2	0.0	654	400	0.10[d]
1985/86	ROE-SN	0.0	2.4	47.2	44.1	2.5	1.1	1.2	0.9	0.6	0.0	1389	400	0.10[d]

FISHERY	AVERAGE WEIGHT AT AGE (gms) 1	2	3	4	5	6	7	8	9	10
REDUCTION	84.4	57.6	89.2	111.2	131.7	145.3	157.3	175.4	190.2	156.6
ROE-SN	0.0	60.2	90.1	117.6	140.5	161.8	173.4	183.8	194.8	206.0
ROE-GN	0.0	0.0	112.1	128.7	144.4	153.9	158.6	167.8	153.7	180.8

[a] - Age composition from published reports.
[b] - Includes catch from "other" fisheries.
[c] - includes catch from gillnet fisheries.
[d] - No seine roe fishery in this season. Age composition from pre-fishery charter samples only.

Appendix table 2.1. Estimates of numbers at age, spawn, and other parameters from age-structured model analysis for the Skincuttle-Laskeek stock assessment region.

Season	Estimated numbers at age (x10^5) for period one										Spawn Index	Estimated Spawn	Spawning Biomass (t)
	1	2	3	4	5	6	7	8	9	10			
1950/51	8368	1680	1309	1598	415	268	0	0	0	120	224	234	23390
1951/52	32326	5336	1068	767	900	234	151	0	0	0	182	174	16520
1952/53	5027	20608	3260	491	292	342	89	57	0	0	342	348	33161
1953/54	4625	3205	13140	2079	313	186	218	57	37	0	685	751	83026
1954/55	2295	2949	2041	8281	1303	196	117	137	36	23	418	634	95000
1955/56	5388	1463	1880	1298	5257	827	124	74	87	23	482	272	20398
1956/57	17087	3434	889	549	181	732	115	17	10	12	108	53	3814
1957/58	2692	10891	2027	208	30	10	40	6	1	1	59	92	10906
1958/59	7381	1716	6428	907	75	11	4	15	2	0	460	352	32219
1959/60	7080	4706	1083	3609	478	40	6	2	8	1	193	320	40729
1960/61	10469	4514	3001	691	2301	305	25	4	1	5	497	531	45664
1961/62	2799	6675	2876	1898	435	1451	192	16	2	1	286	380	46005
1962/63	8829	1785	4235	1647	1032	237	789	105	9	1	277	453	42974
1963/64	1705	5629	1127	2209	775	486	111	371	49	4	189	164	16021
1964/65	1818	1087	3537	375	438	154	96	22	74	10	89	60	6037
1965/66	1499	1159	644	761	11	13	4	3	1	2	220	98	7238
1966/67	2055	956	711	329	346	5	6	2	1	0	37	65	9437
1967/68	1959	1311	609	448	206	217	3	4	1	1	54	93	11122
1968/69	7611	1249	835	386	284	130	137	2	2	1	88	115	13073
1969/70	5054	4853	797	532	246	181	83	87	1	1	111	144	15870
1970/71	7081	3223	3094	508	339	157	115	53	56	1	185	233	26496
1971/72	15681	4515	2055	1973	324	216	100	73	34	36	160	261	33599
1972/73	16161	9998	2872	1282	1219	200	134	62	45	21	158	317	41666
1973/74	4498	10304	6356	1780	784	746	122	82	38	28	536	558	62459
1974/75	5072	2868	6553	3956	1095	482	458	75	50	23	269	520	80679
1975/76	6336	3234	1822	4026	2388	660	290	276	45	30	659	755	70934
1976/77	1872	4040	2044	1069	2271	1347	372	164	156	26	863	456	55521
1977/78	39110	1194	2548	1169	580	1233	731	202	89	85	703	593	44624
1978/79	2222	24936	752	1433	619	307	653	387	107	47	546	636	40888
1979/80	1090	1416	15777	444	790	315	150	364	216	60	1377	1021	91599
1980/81	870	695	902	9941	275	475	186	93	226	134	1371	760	93843
1981/82	5363	555	442	558	6004	162	277	113	57	137	1173	821	68291
1982/83	1912	3420	353	274	341	3616	97	169	69	35	927	984	46902
1983/84	412	1219	2165	210	158	193	2042	56	97	40	967	695	37241
1984/85	1063	262	771	1271	117	85	103	1144	31	55	834	389	26945
1985/86	5512	677	166	443	668	57	40	55	609	17	317	215	17748
	Estimated availability at age (λ_j)												
	0.00	0.07	0.69	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
	Estimated relative selectivity at age for gillnet gear												
	0.00	0.00	0.01	0.23	0.75	1.00	0.16	0.16	0.16	0.16			

The coefficients for the Ricker stock-recruitment curve are: alpha = 86.16, beta = 0.4523E-02
The estimated spawn index- escapement conversion factor is 0.512E-02

Appendix table 2.2. Estimates of numbers at age, spawn, and other parameters from age-structured model analysis for the Prince Rupert District stock assessment region.

Season	Estimated numbers at age (x105) for period one										Spawn Index	Estimated Spawn	Spawning Biomass (t)
	1	2	3	4	5	6	7	8	9	10			
1950/51	8148	4524	5995	7917	1137	452	0	0	0	218	1143	992	39658
1951/52	14960	5195	2775	2877	2974	310	111	0	0	0	769	681	18113
1952/53	3558	9538	3178	1187	832	450	36	13	0	0	1060	791	25427
1953/54	14483	2269	6078	1976	726	500	269	22	8	0	913	796	22720
1954/55	5447	9234	1405	2957	764	209	131	71	6	2	893	662	18651
1955/56	9644	3473	5834	703	1211	244	62	39	21	2	991	726	24586
1956/57	21754	6149	2142	3265	357	554	108	28	17	9	1456	743	16331
1957/58	6266	13870	3750	983	1114	80	108	21	5	3	514	600	24970
1958/59	40129	3996	8547	2283	580	636	45	61	12	3	1378	960	38056
1959/60	20608	25587	2524	5017	1264	302	326	23	31	6	1123	1084	42995
1960/61	10501	13140	15603	1441	2643	610	142	154	11	15	1035	976	51185
1961/62	29029	6695	8081	7973	616	910	197	46	50	4	1598	1445	61878
1962/63	5730	18509	4212	4567	4124	289	416	90	21	23	829	1550	54983
1963/64	2063	3654	11256	2264	2153	1673	113	162	35	8	1259	1802	53768
1964/65	1292	1315	2260	6042	1065	870	648	44	63	14	517	978	35954
1965/66	3620	824	802	1130	2470	339	257	191	13	19	361	672	26337
1966/67	3453	2308	520	443	561	1088	144	110	82	5	234	308	12184
1967/68	13157	2201	1415	261	182	181	326	43	33	24	454	343	10536
1968/69	10580	8389	1370	823	142	93	90	162	22	16	77	209	13439
1969/70	3565	6746	5341	859	511	87	57	55	99	13	905	717	23897
1970/71	15974	2273	4284	3324	526	308	52	34	33	60	737	863	32966
1971/72	9927	10185	1422	2623	1980	305	177	30	20	19	1218	1180	37574
1972/73	5157	6330	6469	876	1579	1164	178	103	18	11	757	1426	47176
1973/74	2040	3288	4031	4076	548	979	720	110	64	11	697	1159	51715
1974/75	5754	1301	2093	2529	2506	323	556	437	67	39	851	1420	52807
1975/76	2783	3669	828	1318	1579	1552	200	343	270	41	1174	1401	44917
1976/77	2858	1774	2332	514	801	939	914	119	204	160	1498	889	32812
1977/78	24390	1823	1124	1397	293	427	480	493	64	110	760	777	23189
1978/79	3898	15552	1154	671	771	138	173	251	258	33	833	766	22041
1979/80	4704	2486	9876	710	396	419	69	99	144	148	1572	1187	35269
1980/81	5088	2999	1580	6144	431	231	237	41	59	86	1198	1047	42539
1981/82	13429	3244	1907	985	3763	258	137	143	25	35	1373	1526	46187
1982/83	2450	8562	2065	1200	614	2323	159	84	88	15	1901	1478	44790
1983/84	3337	1562	5460	1317	765	391	1481	101	54	56	2130	1560	44558
1984/85	2727	2128	994	3414	799	433	206	885	61	32	2225	1391	38446
1985/86	3913	1739	1351	610	1976	405	191	115	496	34	2251	1165	29454
	Estimated availability at age (λ_j)												
	0.00	0.05	0.40	0.67	0.93	1.00	1.00	1.00	1.00	1.00			
	Estimated relative selectivity at age for gillnet gear												
	0.00	0.01	0.01	0.19	0.55	1.00	0.12	0.12	0.12	0.12			

The coefficients for the Ricker stock-recruitment curve are: alpha = 77.13, beta = 0.2377E-02
The estimated spawn index- escapement conversion factor is 0.132E-01

Appendix table 2.3. Estimates of numbers at age, spawn, and other parameters from age-structured model analysis for the central coast stock assessment region.

Season	Estimated numbers at age (x10^3) for period one										Spawn Index	Estimated Spawn	Spawning Biomass (t)
	1	2	3	4	5	6	7	8	9	10			
1950/51	4890	2638	3924	4429	793	320	0	0	72	11	813	640	23298
1951/52	30977	3116	1612	1654	1309	164	66	0	0	15	388	317	11273
1952/53	3519	19737	1924	652	445	227	28	11	0	0	710	614	19355
1953/54	3581	2244	12578	1204	404	273	140	17	7	0	512	757	36380
1954/55	8362	2282	1389	6139	483	137	93	47	6	2	574	807	37840
1955/56	13582	5331	1424	775	3143	231	66	44	23	3	413	370	12144
1956/57	15920	8653	3204	555	190	449	33	9	6	3	264	221	7974
1957/58	4996	10141	5205	1102	96	10	22	2	0	0	437	479	19120
1958/59	9202	3184	6222	2682	489	38	4	9	1	0	420	497	20731
1959/60	20904	5863	1944	2599	777	97	7	1	2	0	709	719	27595
1960/61	12932	13328	3589	1187	1545	453	57	4	0	1	339	457	19296
1961/62	12553	8240	8108	1544	367	346	101	13	1	0	1036	873	31644
1962/63	8530	8001	5108	4213	696	148	139	41	5	0	474	539	21412
1963/64	9556	5435	5025	1964	999	93	19	18	5	1	458	463	17602
1964/65	8026	6089	3269	2032	527	173	16	3	3	1	214	404	21334
1965/66	3577	5115	3808	1705	922	214	70	6	1	1	181	188	8486
1966/67	2468	2278	3067	1214	227	2	0	0	0	0	428	227	6269
1967/68	8683	1572	1366	978	162	1	0	0	0	0	413	315	10141
1968/69	8933	5536	980	809	553	88	0	0	0	0	185	308	14187
1969/70	9008	5696	3528	623	513	350	56	0	0	0	742	638	23020
1970/71	13816	5744	3625	2233	393	322	220	35	0	0	378	651	31814
1971/72	8793	8809	3589	2222	1337	231	190	130	21	0	459	733	35663
1972/73	11645	5605	5548	2054	1186	675	116	96	65	10	1080	1151	43385
1973/74	5095	7424	3548	3320	1171	638	356	63	52	35	958	1202	45643
1974/75	4138	3249	4717	2188	1930	594	299	184	32	27	875	1153	47746
1975/76	5024	2638	2064	2912	1278	992	283	156	96	17	1546	1323	39798
1976/77	3321	3203	1670	1234	1604	599	426	135	74	46	1364	831	30512
1977/78	30462	2117	2030	1009	686	742	249	201	64	35	806	606	19192
1978/79	5408	19420	1339	1195	500	220	183	84	68	22	778	749	25010
1979/80	5153	3448	12383	854	762	319	140	117	54	44	1288	1549	53814
1980/81	2213	3285	2199	7893	542	479	199	88	74	34	1497	1866	64236
1981/82	1619	1411	2094	1398	4935	323	277	119	53	44	1436	1374	59393
1982/83	6527	1032	898	1310	850	2824	179	160	69	31	1814	1508	44765
1983/84	2711	4162	657	560	794	486	1566	103	92	40	1292	1012	29735
1984/85	4141	1729	2637	395	316	399	230	797	52	47	1394	833	24987
1985/86	6983	2640	1096	1598	227	164	196	120	417	27	1369	794	23112

Estimated availability at age (λ_j)

0.00	0.06	0.50	0.79	1.00	1.00	1.00	1.00	1.00	1.00

Estimated relative selectivity at age for gillnet gear

0.00	0.00	0.02	0.22	0.68	1.00	0.60	0.60	0.60	0.60

The coefficients for the Ricker stock-recruitment curve are: alpha = 51.10, beta = 0.2060E-02
The estimated spawn index- escapement conversion factor is 0.120E-01

Appendix table 2.4. Estimates of numbers at age, spawn, and other parameters from age-structured model analysis for the northern Strait of Georgia stock assessment region.

Season	Estimated numbers at age (x105) for period one										Spawn Index	Estimated Spawn	Spawning Biomass (t)
	1	2	3	4	5	6	7	8	9	10			
1950/51	12161	6547	2983	1528	370	76	0	0	0	42	3239	2549	17223
1951/52	16092	7745	4109	1239	507	123	25	0	0	0	3047	2769	20635
1952/53	11987	10249	4744	1733	422	173	42	9	0	0	3671	4195	33944
1953/54	5155	7640	6447	2626	905	221	90	22	4	0	2347	4300	44179
1954/55	5214	3285	4823	3309	1226	422	103	42	10	2	3357	4541	39947
1955/56	5329	3321	1988	2261	1342	497	171	42	17	4	1275	2356	24082
1956/57	16675	3394	1967	824	749	445	165	57	14	6	1593	1715	13699
1957/58	8966	10618	2127	732	225	205	122	45	16	4	834	1519	16753
1958/59	4563	5712	6714	1013	304	94	85	51	19	6	2436	2485	19780
1959/60	12712	2905	3323	2273	230	69	21	19	11	4	2136	2357	19043
1960/61	11388	8096	1707	1368	744	75	23	7	6	4	1746	2110	17171
1961/62	12913	7254	4936	761	512	278	28	8	3	2	1677	1887	15891
1962/63	6973	8220	4301	1591	156	105	57	6	2	1	1365	1471	12696
1963/64	4018	4438	4780	1184	223	22	15	8	1	0	1407	1333	11054
1964/65	3683	2557	2655	1263	148	28	3	2	1	0	1609	1013	7843
1965/66	1409	2344	1486	756	193	23	4	0	0	0	333	379	3666
1966/67	1233	897	1369	343	60	15	2	0	0	0	613	319	1691
1967/68	3092	784	520	237	0	0	0	0	0	0	674	480	3106
1968/69	3279	1970	484	268	112	0	0	0	0	0	977	730	5044
1969/70	3425	2091	1240	292	159	66	0	0	0	0	2226	1401	9149
1970/71	4499	2183	1325	763	178	97	40	0	0	0	2233	1866	13566
1971/72	6027	2869	1378	817	465	108	59	24	0	0	1619	1725	13286
1972/73	11059	3840	1779	687	366	208	48	26	11	0	1453	1733	14990
1973/74	6612	7048	2407	983	341	160	83	21	12	5	3204	2887	21541
1974/75	13470	4216	4494	1526	561	151	59	37	10	5	4357	4139	32507
1975/76	8418	8588	2682	2794	848	242	54	26	16	4	4598	5050	37248
1976/77	3841	5367	5460	1661	1556	374	90	24	11	7	6156	5522	43276
1977/78	7323	2449	3398	3270	888	669	137	39	10	5	5014	5245	41451
1978/79	5864	4668	1543	1956	1675	377	248	59	17	4	4541	4645	35382
1979/80	5466	3739	2967	956	1113	797	157	119	28	8	5085	4836	36005
1980/81	5175	3485	2378	1849	570	610	410	86	65	15	3469	4089	33673
1981/82	4553	3299	2210	1445	1035	273	261	198	42	31	6465	4743	32024
1982/83	6421	2903	2103	1401	851	513	119	130	98	21	3530	2882	20564
1983/84	13168	4092	1815	1119	583	233	104	33	36	27	2529	2277	16667
1984/85	10547	8393	2574	1021	494	161	46	29	9	10	2255	2556	21365
1985/86	6909	6723	5302	1507	516	189	50	18	11	4	4437	4869	40332
	Estimated availability at age (λ_j)												
	0.00	0.09	0.73	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
	Estimated relative selectivity at age for gillnet gear												
	0.00	0.00	0.02	0.20	0.66	1.00	0.65	0.65	0.65	0.65			

The coefficients for the Ricker stock-recruitment curve are: alpha = 7.230, beta = 0.3451E-03
The estimated spawn index-escapement conversion factor is 0.550E-01

Appendix table 2.5. Estimates of numbers at age, spawn, and other parameters from age-structured model analysis for the southern Strait of Georgia stock assessment region.

Season	Estimated numbers at age (x10^5) for period one										Spawn Index	Estimated Spawn	Spawning Biomass (t)
	1	2	3	4	5	6	7	8	9	10			
1950/51	11192	5975	3669	1170	235	46	0	0	0	0	339	692	12321
1951/52	17442	7124	3678	1081	252	50	10	0	0	0	918	916	12884
1952/53	14142	11103	4304	1105	240	56	11	2	0	0	2974	2046	30627
1953/54	11851	9017	7076	2707	693	151	35	7	1	0	2121	1762	28487
1954/55	10892	7545	5651	2382	723	185	40	7	1	0	1690	1402	24544
1955/56	6235	6935	4663	1922	646	196	50	9	2	0	1111	1015	14330
1956/57	12821	3968	4200	1134	292	98	30	4	1	0	467	570	8184
1957/58	12738	8157	2400	824	107	27	9	0	0	0	1056	824	12090
1958/59	6257	8112	5079	905	261	34	9	2	0	0	1257	1424	23244
1959/60	16413	3986	4939	2365	385	111	14	3	1	0	617	868	15256
1960/61	11121	10446	2361	1332	437	71	21	2	0	0	719	771	11775
1961/62	8894	7078	5918	655	258	85	14	3	0	0	383	657	14914
1962/63	4730	5661	4323	1620	124	49	16	2	0	0	578	612	12304
1963/64	2577	3010	3237	1130	282	22	9	2	0	0	615	482	6021
1964/65	7673	1640	1702	600	91	23	2	0	0	0	181	169	3149
1965/66	776	4881	927	316	48	7	2	0	0	0	232	200	3428
1966/67	928	494	2803	190	33	5	1	0	0	0	160	200	3570
1967/68	2242	590	279	520	15	3	0	0	0	0	269	241	3510
1968/69	2298	1429	358	136	236	7	1	0	0	0	410	296	4392
1969/70	1770	1465	897	212	79	137	4	1	0	0	678	467	7162
1970/71	2588	1128	928	556	130	49	85	2	0	0	575	547	9608
1971/72	3222	1650	710	570	339	79	30	51	1	0	542	566	9880
1972/73	3986	2054	1033	404	311	184	43	16	28	1	531	581	11868
1973/74	2569	2541	1307	646	239	180	106	27	10	17	830	814	14814
1974/75	4557	1638	1616	819	392	143	108	66	17	6	833	896	17953
1975/76	4156	2906	1044	1023	491	229	84	68	42	11	646	730	17381
1976/77	1773	2649	1835	609	559	262	122	47	38	24	372	654	17250
1977/78	2726	1130	1660	994	305	274	129	62	24	19	832	718	14245
1978/79	2249	1737	693	799	420	125	113	54	26	10	1783	647	8196
1979/80	1972	1432	1055	269	263	138	41	32	15	7	891	536	10005
1980/81	1050	1257	907	630	158	155	81	24	19	9	659	489	9348
1981/82	1278	669	780	463	303	76	74	37	11	9	246	298	5818
1982/83	1912	813	390	298	153	100	25	22	11	3	501	409	5969
1983/84	3746	1219	515	230	173	89	58	14	13	6	557	400	6402
1984/85	2025	2388	762	300	131	98	51	33	8	7	556	513	8405
1985/86	2978	1291	1506	463	180	79	59	30	19	5	570	637	12723
	Estimated availability at age (λ_j)												
	0.00	0.11	0.71	0.87	0.87	0.87	1.00	1.00	1.00	1.00			
	Estimated relative selectivity at age for gillnet gear												
	0.00	0.03	0.08	0.67	1.00	0.96	0.06	0.06	0.06	0.06			

The coefficients for the Ricker stock-recruitment curve are: alpha = 6.530, beta = 0.1301E-10
The estimated spawn index-escapement conversion factor is 0.256E-01

Appendix table 2.6. Estimates of numbers at age, spawn, and other parameters from age-structured model analysis for the southern west coast of Vancouver Island stock assessment region.

Season	Estimated numbers at age (x10^5) for period one										Spawn Index	Estimated Spawn	Spawning Biomass (t)
	1	2	3	4	5	6	7	8	9	10			
1950/51	3552	2923	1274	987	145	29	1	4	0	0	492	296	5172
1951/52	6252	2265	1711	330	148	18	3	0	0	0	397	258	5349
1952/53	3041	3986	1389	510	66	26	3	1	0	0	677	541	11894
1953/54	5446	1939	2542	885	325	42	17	2	0	0	466	247	4413
1954/55	4010	3472	1121	471	48	7	0	0	0	0	616	345	6048
1955/56	5734	2557	2133	436	149	14	2	0	0	0	605	290	4292
1956/57	9387	3656	1481	440	36	8	1	0	0	0	437	404	9581
1957/58	4885	5985	2309	808	228	18	4	0	0	0	884	829	19675
1958/59	4972	3115	3808	1444	502	142	11	2	0	0	394	360	7541
1959/60	10278	3170	1805	754	103	20	4	0	0	0	477	291	5480
1960/61	4431	6553	1833	455	106	12	2	0	0	0	482	402	8244
1961/62	8527	2825	3790	641	121	26	3	0	0	0	697	533	12374
1962/63	3349	5437	1728	1342	174	30	6	1	0	0	401	573	18034
1963/64	2406	2136	3451	960	713	92	16	3	0	0	979	705	15658
1964/65	2589	1534	1309	1278	281	195	24	4	1	0	657	495	11174
1965/66	3098	1651	950	522	422	88	60	7	1	0	257	304	8797
1966/67	2497	1976	1033	417	199	155	32	21	3	0	140	185	4393
1967/68	6997	1592	1154	291	75	31	22	4	3	0	362	399	8892
1968/69	14710	4461	1015	736	186	48	19	14	3	2	447	545	13861
1969/70	8644	9379	2845	647	469	118	30	12	9	2	1045	1059	26283
1970/71	12438	5512	5980	1814	413	299	75	19	8	6	1334	1564	48373
1971/72	16251	7931	3514	3813	1157	263	191	48	12	5	1145	1613	58404
1972/73	25541	10362	5029	2147	2300	695	158	114	29	7	510	1482	65043
1973/74	9996	16285	6540	2956	1222	1282	382	89	65	16	695	1928	80090
1974/75	5688	6373	10341	4025	1762	696	702	227	53	38	1297	2389	96426
1975/76	6673	3627	4029	6126	2238	896	329	390	126	29	1457	2827	75504
1976/77	1876	4255	2277	2243	2984	896	305	160	190	61	1649	1930	49122
1977/78	4631	1196	2658	1217	1048	1173	306	141	74	88	1368	1402	33196
1978/79	3993	2953	753	1500	586	391	353	149	68	36	1307	1079	23204
1979/80	2481	2546	1853	417	736	243	141	173	73	33	1322	1102	23883
1980/81	2037	1582	1613	1123	247	426	138	83	102	43	1275	1010	21919
1981/82	3181	1299	998	938	608	121	194	74	45	55	837	808	19390
1982/83	6422	2028	819	584	528	331	64	108	42	25	527	573	14038
1983/84	9198	4095	1256	407	266	235	146	28	47	18	587	531	12940
1984/85	4311	5865	2535	623	185	118	104	64	12	21	803	869	22304
1985/86	6985	2749	3737	1608	394	117	75	66	41	8	936	1250	35321
	Estimated availability at age (λ_j)												
	0.00	0.09	0.71	0.91	0.97	0.98	1.00	1.00	1.00	1.00			
	Estimated relative selectivity at age for gillnet gear												
	0.00	0.00	0.05	0.26	0.67	1.00	0.21	0.21	0.21	0.21			

The coefficients for the Ricker stock-recruitment curve are: alpha = 20.01, beta = 0.1038E-02
The estimated spawn index- escapement conversion factor is 0.199E-01

Appendix table 2.7. Estimates of numbers at age, spawn, and other parameters from age-structured model analysis for the northern west coast of Vancouver Island stock assessment region.

Season	Estimated numbers at age (x105) for period one										Spawn Index	Estimated Spawn	Spawning Biomass (t)
	1	2	3	4	5	6	7	8	9	10			
1950/51	3336	651	1100	1923	303	95	6	0	0	19	863	704	16316
1951/52	6182	2127	410	596	959	149	47	3	0	0	345	269	4895
1952/53	3581	3942	1338	136	114	158	25	7	0	0	1256	620	9143
1953/54	3640	2283	2513	853	86	73	101	16	4	0	929	611	11944
1954/55	6009	2321	1439	1169	330	32	27	36	6	2	827	626	13028
1955/56	6228	3831	1442	747	543	150	15	12	16	2	1180	758	16988
1956/57	6009	3971	2441	905	465	338	93	9	7	10	1854	852	23551
1957/58	8812	3832	2531	1539	568	292	212	58	6	5	660	890	30715
1958/59	4160	5619	2443	1612	980	362	186	135	37	4	565	532	12925
1959/60	10136	2653	3519	818	318	169	62	28	20	6	295	278	5928
1960/61	6215	6463	1625	857	53	10	5	0	0	0	340	249	4527
1961/62	4943	3963	3962	449	96	4	1	0	0	0	630	645	12134
1962/63	2309	3152	2461	1708	151	31	1	0	0	0	522	618	11706
1963/64	2121	1472	1987	973	487	40	8	0	0	0	613	780	17239
1964/65	2467	1352	936	1201	573	286	23	5	0	0	851	1017	16751
1965/66	993	1573	857	534	649	306	153	12	3	0	295	636	14039
1966/67	1341	633	993	474	275	329	156	76	6	1	423	445	9525
1967/68	4468	855	395	466	187	104	125	57	28	2	286	388	9687
1968/69	6445	2849	545	252	297	119	66	80	36	18	544	507	9889
1969/70	3789	4110	1817	348	161	190	76	42	51	23	710	683	14616
1970/71	3584	2416	2620	1158	222	103	121	48	27	32	515	749	22617
1971/72	4520	2285	1541	1671	739	141	65	77	31	17	982	818	25001
1972/73	7155	2882	1454	935	991	436	83	38	45	18	775	948	20601
1973/74	1712	4562	1830	778	457	475	209	39	18	21	315	644	15568
1974/75	1858	1091	2878	861	307	174	181	77	14	7	718	659	17780
1975/76	8179	1185	690	1483	396	138	78	80	34	6	1380	905	14955
1976/77	2089	5215	753	395	767	179	56	28	28	12	645	609	12686
1977/78	4578	1332	3322	465	226	375	76	20	10	10	1126	1011	17908
1978/79	1286	2919	847	2020	252	96	129	21	5	3	2855	1131	13078
1979/80	1035	820	1851	448	819	67	18	15	2	1	1692	1256	15606
1980/81	547	660	523	1177	265	409	28	6	5	1	796	1065	12438
1981/82	509	349	418	304	612	116	155	9	2	2	991	574	8683
1982/83	3668	324	222	262	173	282	44	48	3	1	751	354	5038
1983/84	4755	2339	207	141	146	71	87	10	11	1	540	276	4156
1984/85	5490	3032	1491	132	84	74	31	33	4	4	316	358	8850
1985/86	5869	3501	1933	950	84	53	47	20	21	2	824	789	16045
	Estimated availability at age (λ_j)												
	0.00	0.04	0.62	0.90	0.95	0.95	1.00	1.00	1.00	1.00			
	Estimated relative selectivity at age for gillnet gear												
	0.09	0.00	0.01	0.15	0.45	0.75	1.00	1.00	1.00	1.00			

The coefficients for the Ricker stock-recruitment curve are: alpha = 58.31, beta = 0.3546E-02
The estimated spawn index-escapement conversion factor is 0.219E-01